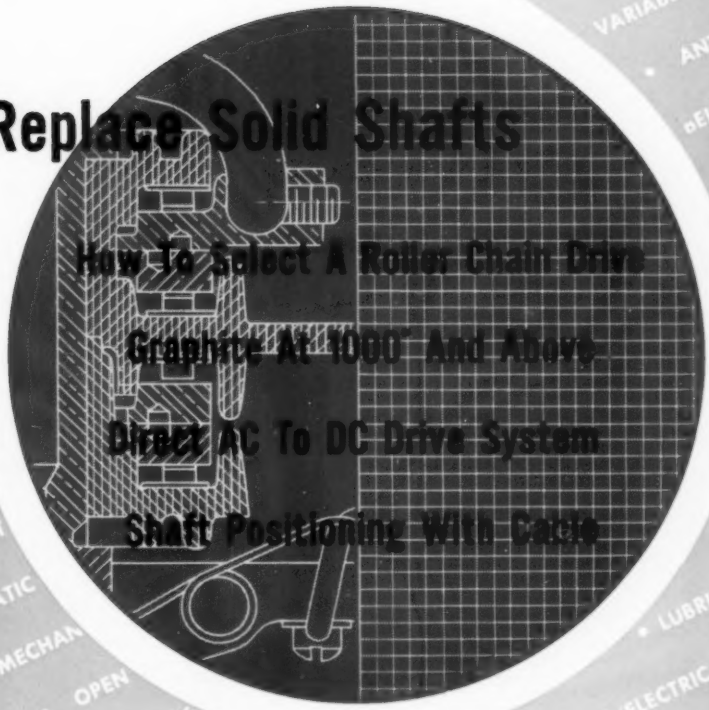
POWER TRANSMISSION DESIGN

MARCH 1959

OEM · MAINTENANCE

Hollow Shafts Replace Solid Shafts



How To Select A Roller Chain Drive

Graphite At 1000° And Above

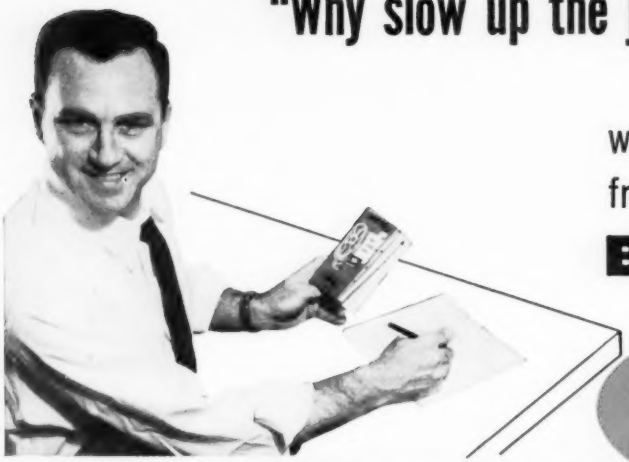
Direct AC To DC Drive System

Shaft Positioning With Cams

THE MAGAZINE OF MACHINE DRIVES

News and ideas for designers and plant engineers who use power drive equipment

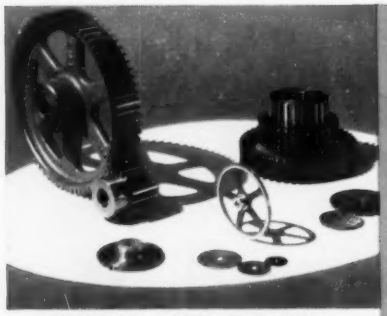
"Why slow up the job with special gears?"



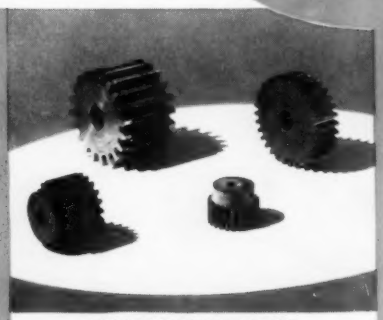
when you can select what you need from over 2000 standardized

BOSTON GEARS

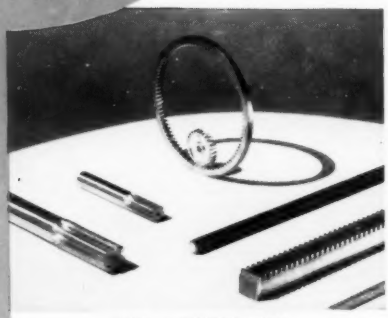
FROM STOCK
OFF-THE-SHELF
at factory prices



SPUR GEARS — STEEL, IRON, BRASS
14½° and 20° P.A. .208" to 40" P.D.

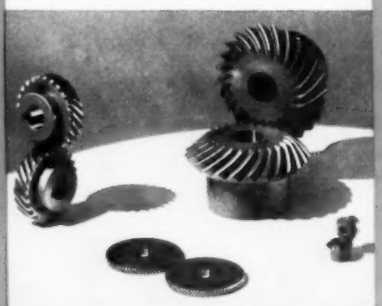


NON-METALLIC SPUR GEARS
14½° and 20° P.A. .938" to 6.667" P.D.

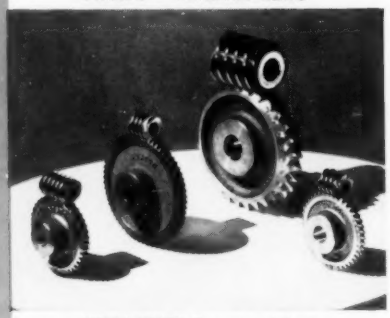


RACK • PINION WIRE
Steel and Brass 14½° and 20° P.A.
PINIONS • INTERNAL GEARS

BEVEL and MITER GEARS
Steel, Iron, and Brass 20° P.A.
.312" to 14" P.D.



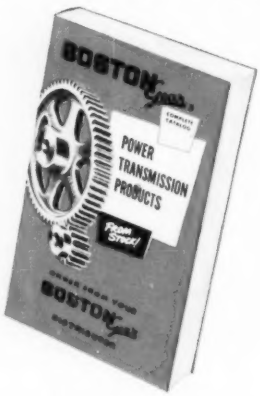
STEEL SPIRAL MITERS 1" to 5" P.D.
HELICAL GEARS
Steel and Bronze .333" to 6" P.D.



WORM GEARS Bronze and Iron
.417" to 18" P.D. **WORMS** .333" to 4" P.D.
Soft Steel and hardened and ground steel

9496
STANDARDIZED TRANSMISSION PRODUCTS

Stock Gears
Sprockets and Chain
Speed Reducers
Bearings • Couplings
Shaft Supports
Pulleys



Take a good look through the BOSTON Gear catalog. You'll find standardized types and sizes to fit most of today's transmission needs. Why pay more (and wait) for gears made to order? Design around BOSTON Gear. It saves time and money in planning, in purchasing, in production . . . and you simplify servicing problems. Boston Gear Works, 94 Hayward Street, Quincy, Mass.

CALL YOUR
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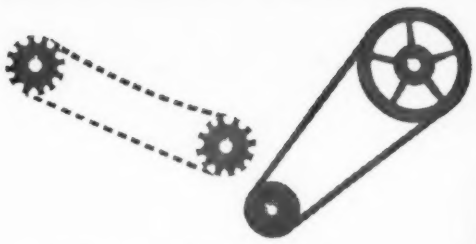
— STANDARDIZATION PAYS —

Yellow Pages

For more information circle No. 14 on the Reader Service Card

maurey DRIVES

make productive machines



Maurey V-Drives and Roller Chain Drives upgrade a machine three important ways:

PRODUCTION-wise
They drive the full power of the motor into your machine's productive "muscles."

DESIGN-wise
They conserve space for modern trimness.

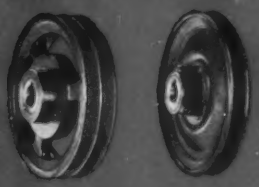
MAINTENANCE-wise
They make repairs and replacements, when necessary, simple, quick and low in cost.

Why not give your machine the production lift and the modern look that a Maurey Drive assures? A Maurey power transmission specialist will be glad to help with your drive plans, at no obligation. And you can depend on Maurey delivery to keep your production on schedule.

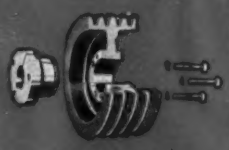
Call your local Maurey Drive distributor, or write for any one or all of these Maurey Power Transmission Catalogs:

- FHP V-Drive Catalog F-10
- V-Belt Catalog No. 55
- Multiple V-Drive Catalog, MVD-58
- Maureymatic Variable Speed Transmission Catalog No. MM-58
- V-Drive Engineering Manual
- Roller Chain Drive Catalog D-58
- Conveyor Pulley Catalog CV-1

the complete, *engineered* drive line



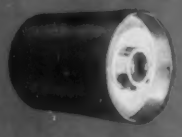
Hi-Q FHP V-Pulleys



FUL-GRIP Q-D Sheaves

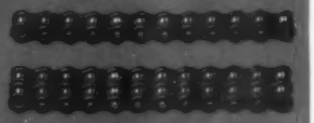
Mor-Grip Green Seal V-Belts

Maureymatic
Variable Speed Transmissions



Conveyor Pulleys

Sprockets



Roller Chains

And a complete line
of Drive Accessories

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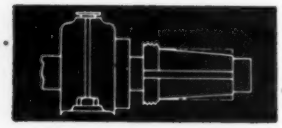
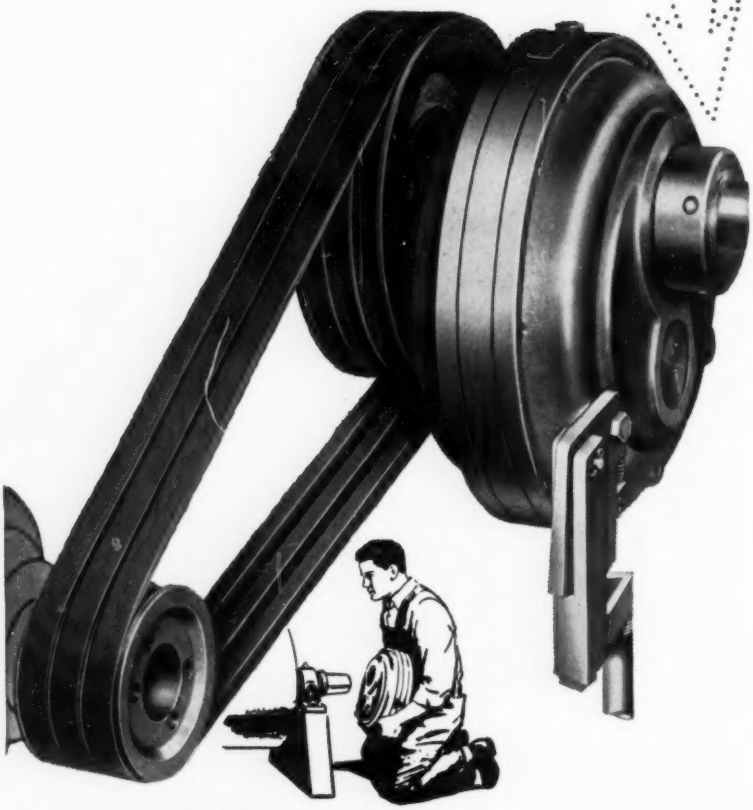
Easy on . . .
Easy off with American's *exclusive* Tapered-Hub Shaft-King Speed-Reduction Drives





Plus FLEXIBILITY

Any speed you need . . . by sheave substitution or adjustable speed V-belt drives

Plus SAFETY

Unique overload release and either internal or external backstop . . . for extra safety

Plus ECONOMY

Modern tear-drop contour . . . saves space and eliminates clearance problem

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8 belts do a 10-belt job— 6 times as long

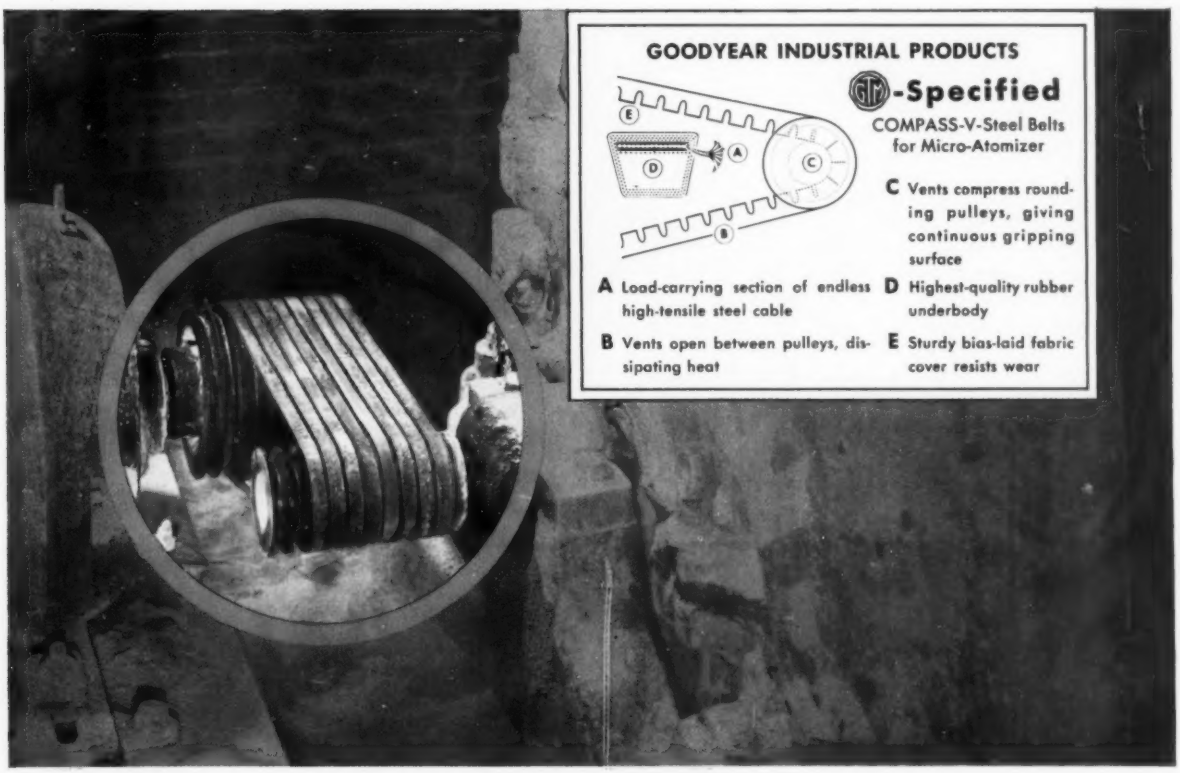
SMASHING chunks of nickel formate into small, dust-like particles is rugged business. What with the short-centered, dusty, 5,868 f.p.m. drives on their busy micro-atomizer, this Midwestern chemical plant was replacing whole sets of V-belts every 3 to 4 weeks.

Obviously, this heavy, month-after-month expense had to stop. Hopefully, they turned to the G.T.M.—Goodyear Technical Man. Confidently, he recommended COMPASS-V-Steel Belts with the Green Seal – built around airplane-type steel cable.

Thanks to this built-in strength, 8 of these super belts were able to handle what had always been a 10-belt job. And thanks to their unmatched toughness and dimensional stability, the G.T.M.'s belts had served a full 6 months at last report – looked good for at least 6 more.

And that's a typical experience. In countless belting jobs, COMPASS-V-Steel Belts with the Green Seal are giving longer service with fewer belts using smaller, less costly pulleys. Get the full moneysaving story from your Goodyear Distributor – or by writing Goodyear, Industrial Products Division, Lincoln 2, Nebraska, or Akron 16, Ohio.

IT'S SMART TO DO BUSINESS *with your Goodyear Distributor. He can give you fast, dependable service on V-Belts, Hose, Flat Belts and many other industrial rubber and non-rubber supplies. Look for him in the Yellow Pages under "Rubber Goods" or "Rubber Products."*



V-BELTS WITH THE GREEN SEAL by

GOODYEAR

Green Seal, Compass—T. M.'s The Goodyear Tire & Rubber Company, Akron, Ohio

THE GREATEST NAME IN RUBBER

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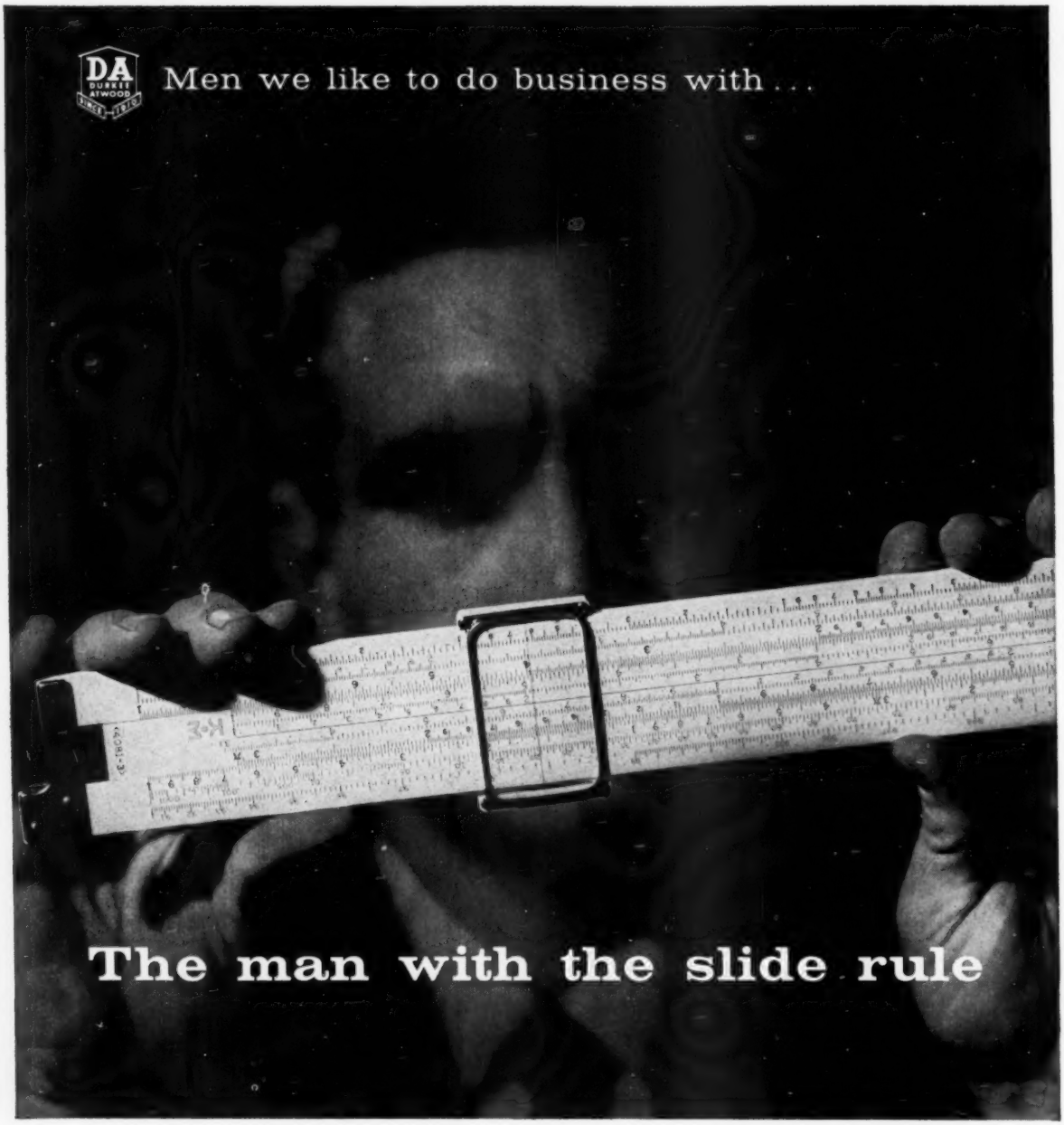

He gives that "extra" study and analysis to every product he buys. He asks searching questions and demands proof of quality—probes into the important factors of costs and product durability. He wants to be assured of good, prompt service, too.

That's the kind of man we like to do business with, because we can show him exactly how he gets extra benefits with Durkee-Atwood V-Belts. Durkee-Atwood offers V-Belt *Quality* that meets the most demanding needs of industry, quality that has proven itself under severe usage . . . prompt *Service* when you need special attention and help . . . real money *Savings*, too (and the eyes of the "slide rule" man light up at that).

Durkee-Atwood, one of America's pioneer V-Belt manufacturers, offers a complete line of Multiple V-Belts, General Duty V-Belts and Steel Cable V-Belts—built to *last*!

DURKEE-ATWOOD V-BELTS

DURKEE-ATWOOD COMPANY • MINNEAPOLIS 13, MINNESOTA

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POWER TRANSMISSION DESIGN

READERS' GUIDE

March 1959, *volume 1 number 3*

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FACTS

and figures on products and literature of interest to designers, engineers, and other power transmission design people can be had by circling the right numbers on the reader service cards found opposite page 48.

NEWS

from the power transmission field

ASLE holds first Gear Symposium

Chicago, Ill.—The American Society of Lubrication Engineers held its first Gear Symposium at the Morrison Hotel, Chicago, on January 26 and 27. Purpose of the two-day meeting was to show gear designers and lubrication engineers that design and lubrication are both necessary for proper gear operation at high speeds and loads. General chairman of the meeting was Dr. T. W. Havely, Shell Oil Co., Woodriver, Ill.

Chairman at the first morning session was R. K. Nelson, chief engineer, Eppi Precision Products Co. Papers given were: "Gear Lubrication—The Known and the Unknown" by Al Hundere, Alcor Inc. and "The Gear Rig as an Oil Tester" by Earle A. Ryder, consulting engineer. At the afternoon session, P. M. Ku and B. B. Baber gave "The Effects of Lubricants on Gear Tooth Scuffing." Other papers were: "Recent Developments in the Lubrication of Heavy-Duty Gearing" by G. P. Maurer, Falk Corp. and "Efficiency of Involute Spur Gears" by E. E. Shipley, General Electric Co. L. J. Collins, General Electric Co. was chairman of this session.

The second morning's subject was "E. P. Lubricants and Hypoid Gearing" with L. L. Withrow, General Motors Research Staff, as chairman. Papers given were: "A Laboratory Rating Method for E. P. Lubricants" by A. J. DeArdo and L. B. Sargent, Jr., Aluminum Co. of America; "Analytical Study of Surface Loading and Sliding Velocity of Automotive Hypoid Gears" by D. L. Powell and H. R. Barton, Armour Research Foundation; "Limited Slip Differentials" by L. J. O'Brien, Dana Corp.; and "High Horsepower and High Torque Performance of E. P. Gear Lubricants" by R. K. Nelson.

"Boundary Lubrication" was the topic for Tuesday afternoon. W. E. Campbell, consultant, AFRAM was chairman. Papers at this session were: "Apparent Viscosity of Lubricant Films under Very Low Shear Rates" by E. K. Gatcombe, professor of mechanical engineering, USN Postgraduate School, R. P. Hunnicut, Dalmo Victor Co., and G. F. Kinney, professor of chemical engineering, USN Postgraduate School; and "Wear in Heavily Loaded Lubricated Surfaces Subjected to Oscillating Motion" by J. F. Batter and F. E. Reed, Technical Operations Inc.

Copies of all these papers are available from ASLE, 84 E. Randolph St., Chicago, Ill. at a cost of 50 cents each to members and 75 cents each to nonmembers.

Bearing company triples capacity

Lebanon, N. H.—A new plant, unveiled recently, will let Split Ballbearing, a division of Miniature Precision Bearings Inc., triple its capacity.

The plant has been carefully laid out so that there is a natural flow of materials from receiving to shipping room with no backtracking. Most areas of the plant are air conditioned. The final assembly area, called the White Room, is air conditioned, filtered and pressurized. All particles larger than one micron are filtered from the air entering this room to assure that there will be no dirt in the finished bearings. Anyone entering this room must pass through an airlock and put on a nylon smock and cap. A vacuum shoe cleaner and a gelatinous mat in the airlock make sure there are no dust particles on shoes.

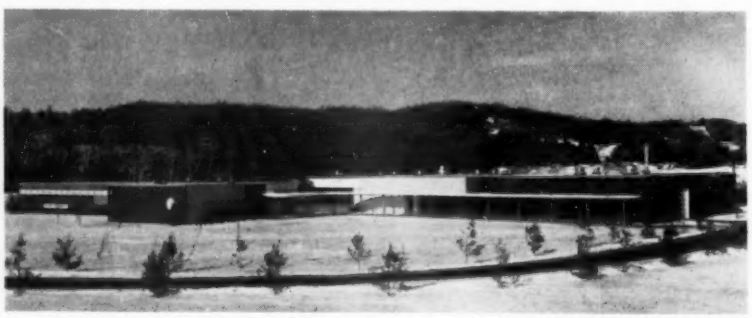
Electric power right from atoms

San Jose, Calif.—Completion of an eight-day experiment in which electricity was produced directly from a radioisotope by a thermionic converter was announced recently by General Electric's Atomic Power Equipment Dept. Isotope used in the experiment was gold, a strip about 4 by 6 by 1/16 in. The thermionic converter uses two small discs about the size of half dollars. It has no moving parts.

The experiment produced enough power to operate a small radio transmitter, but, of more

Continued on page 8

NEW PLANT of Split Ballbearing at Lebanon, N. H.



FALK All-Motor Motoreducers driving pipe conveyors in seamless tube mill.

Photo courtesy of
The Colorado Fuel and Iron Corporation

You get these "extras" when you buy FALK *all-steel* Motoreducers

1. **Freedom from damaged housings.** The exclusive FALK *all-steel* construction gives full protection from cracked housings or torn-off feet...plus twice the ability of cast iron to maintain vital alignment.
2. **12-15% reserve load-carrying capacity** in the gears, by AGMA standards. The extra-depth, high pressure angle helical gears are another FALK exclusive ...they assure better operation and longer gear life.
3. **Highest known gear efficiency**—98½% per gear train under full load! This means maximum productive work for your power dollar.
4. **Longer service life**...advanced FALK design makes it possible to machine both bores for each shaft assembly at one time, thus eliminating possible accumulation of tolerances that occurs when individually machined parts are assembled. The result—better alignment of revolving elements that permits units to transmit rated capacity longer.
5. **Standard units to fit your needs.** Integral and All-Motor® Motoreducers are available in horizontal, vertical and right angle types...a type for every use.

Units are available up to 75 hp; output speeds from 780 rpm down to 1.2 rpm. Prompt delivery from factory, warehouse or distributor stocks. Ask your FALK Representative or Authorized FALK Distributor for *Bulletin 3100.*

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MANUFACTURERS OF QUALITY GEAR DRIVES AND FLEXIBLE SHAFT COUPLINGS

Representatives and Distributors in most principal cities

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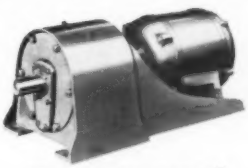
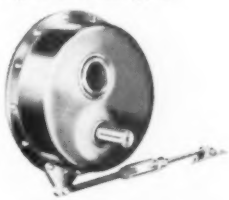
...a good name in industry



THE FALK ALL-MOTOR® MOTOREDUCER

the original All-Motor unit

(Shown) Horizontal concentric model. Also available in right angle and vertical types.



THE ALL-STEEL FALK® SHAFT MOUNTED DRIVE

Proved best for the countless industrial applications where a reducing unit mounting directly on shaft of the driven machine is indicated.

Units from 1/2 to 50 hp. Ratios —4:1, 14:1 or 24:1. Torque capacity up to 41,000 lb-in (in standard units). Prompt shipment from stock. For details, ask for *Bulletin 7100.*

Circle No. 19 on Reader Service Card

4 Reasons Why OHIO Stock Gears are a Better Buy!

1 Better Value

OHIO gears are a better value because you get top quality gears at lower prices. Ask for a quotation and see for yourself.

2 Top Quality

OHIO gears have gained universal acceptance among major users, through a combination of experienced engineering, fine materials and quality workmanship.

3 Availability

52 OHIO distributors, located in major cities across the nation, can make fast delivery on all popular styles and sizes . . . from local stock.

4 Wide Selection

All sizes of OHIO gears are available in both 14½ and 20 degree pressure angle, and includes: spur, 3 to 64 pitch; worm, 3 to 32 pitch; bevel, 3 to 16 pitch; mitre, 4 to 32 pitch; and helical, 6 to 24 pitch.

Why not make your own comparison by getting a competitive quotation on your stock gear needs. See your local OHIO distributor or write direct.

Get This Handy Catalog — the only gear catalog planned and indexed to put complete information at your finger tips.

Ohio **OHIO GEAR Company**
1325 East 179th St. • Cleveland 10, Ohio

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importance, established feasibility of a power pack generating more than 100 watts of electricity for longer than a year and weighing less than 25 lb. The relatively low efficiency of this direct conversion apparatus make it suitable primarily for special applications where long life and low weight are important, say GE engineers.

Four companies join NEMA

New York, N. Y.—Four additional companies have been added to the membership rolls of the National Electrical Manufacturers Association. They are:

Electrolux Corp., Old Greenwich, Conn. affiliated with the Motor and Generator Section. Robert Weeks, Jr., assistant chief engineer is voting representative,

Philadelphia Insulated Wire Co,. Philadelphia, Pa., affiliated with the Wire and Cable Section. J. J. Dowling, president, is voting representative.

Monitor Controller Div., Industrial Electronics Co. Inc., Rockland, Mass., affiliated with Industrial Control Section. R. J. Quinn, Jr., vice president, is voting representative.

Reynolds Metals Co., Richmond, Va., Arc Welding and Wire and Cable Sections. Walter M. Franklin, director, Electrical Markets Sales is voting representative.

Clutch mfr. gets U. S. rights to German clutches

Racine, Wis.—Exclusive manufacturing and sales rights to the Ortlinghaus line of electromagnetic clutches for the United States and Canada as well as sales rights for the United Kingdom have been obtained by the Twin Disc Clutch Co. These rights are part of a cross-license agreement that will let Ortlinghaus make and sell Twin Disc fluid couplings in Germany.

Ortlinghaus is Europe's foremost maker of industrial clutches and their electromagnetic clutches are recognized through-

out the world as being among the finest of their kind. This addition completes Twin Disc's line of industrial clutches. They already have mechanical, air, and oil-actuated types.

NLGI to survey 1958 lubricant production

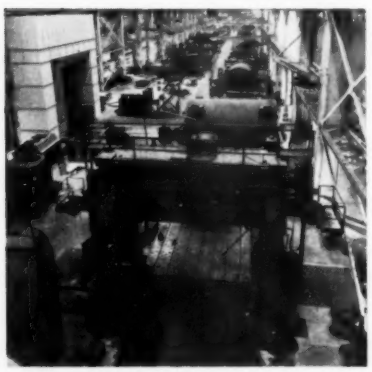
Kansas City, Mo.—Second annual survey of production of lubricating greases and fluid gear lubricants has been started by the NLGI. This year's survey will include Canadian as well as U. S. members. More than 95% of all lubricating grease and fluid gear lubricant manufacturers belong to the NLGI.

Management services div, Ernst & Ernst, national certified public accountants will handle the operation. All replies are anonymous and the information confidential.

Members of the survey committee for NLGI are: W. H. Saunders, Jr., chairman (president, International Lubricants Corp.); F. R. Hart (Standard Oil of California); G. Landis (Atlantic Refining Co.); and G. E. Merkle (Fiske Brothers Refining).

Gear mfg. facilities expanded

Lynn, Mass.—Full-scale operations are underway in a new 59,000 sq ft extension to General



NEW EXTENSION of General Electric Co.'s Medium Steam Turbine, Generator and Gear Dept.

Electric's Medium Steam Turbine, Generator and Gear Dept. The new building is part of a $23 million expansion and modernization program started in 1956 and to be completed in 1961.

This department of the company manufactures steam turbine-generator units, marine turbines and reduction gears, mechanical drive turbines, high-speed precision gears, and transportation gearing.

Big motors power largest steam power plant

Memphis, Tenn. — Six large pumps powered by six 1250 hp synchronous motors will supply up to a half billion gallons of cooling water a day at the Thomas H. Allen Electric Generating Station here.

The new station is one of the largest steam power plants ever authorized by any municipality. Its rating is 750,000 kw derived from three tandem compound turbine generators. The station was designed by Burns and Roe, Inc., New York, N. Y.

Speed control mfr. establishes repair stations

Minneapolis, Minn.—New repair stations on both East and West coasts have been established for repairing Zero-Max speed controls by Revco, Inc. West-coast station is Minarik Electric Co., 224 E. Third St., Los Angeles 13. East-coast shop is John's electrical Repair Service, 50 Dey St., New York 7.

Repairs will also be made at the factory in Minneapolis. The company suggests that jobs west of the Rockies go to Los Angeles, east of the Alleghenies to New York, and all others to Minneapolis.

Bearing mfr. appoints factory rep.

Danbury, Conn.—The Tompkins Co., Kansas City, Mo., has been made factory representatives for The Barden Corp. in the Mountain and most of the Central states. The Tompkins firm also has offices in Dallas and Denver and will serve both OEM and replacement accounts for the Barden line of ball bearings.

Servospeed
HEART OF AUTOMATION
MODERN ELECTRONIC ENGINEERING GIVES PRECISE MOTOR SPEED CONTROL
1/100 — 10 H. P.
Modern industrial electronic engineering has been coordinated with electric motor design to provide a versatile means for obtaining the full possible advantage of speed control in DC motors while operated from the regular alternating current power line. Grid controlled "Thyratron" tubes are utilized for power controlled stepless variation to supply motor armature power. Patented feedback, or "Servo" circuits provide constant torque capability over wide speed ranges of as high as 60 to 1 in some models and a minimum of 20 to 1 in others.
Servospeed
DIV. of ELECTRO DEVICES, Inc.
4 Godwin Ave., Paterson, N. J.
ARmory 4-8989

Circle No. 58 on Reader Service Card

MEN

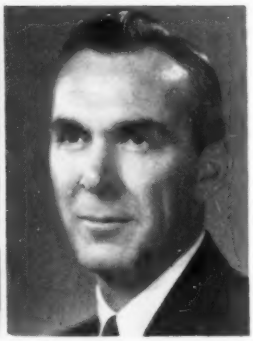
of the power transmission industry

Richardson

Scannell

Wellauer

Maurer



Falk

Falk Corp. appoints new VP promotes others

Thomas F. Scannell is now Vice President as well as General Sales Manager of the Falk Corporation, Milwaukee, Wisconsin.

General Sales Manager of the company since 1943, Scannell is a graduate of Yale University and a Navy veteran of World War One. He joined Falk in 1928 as manager of the St. Louis office. In 1933 he became manager of the Southwestern District with headquarters in Dallas, going to Milwaukee in 1940 as assistant to the Sales Manager. The following year he became Sales Manager, and in 1943 was made General Sales Manager.

Scannell has served on the executive committee of the American Gear Manufacturers' Association, and is a member of the American Petroleum Institute.

The Falk Corporation also announces several promotions in the Engineering Division. George P. Maurer becomes Director of Gear Engineering; W. Stephan Richardson, Chief Engineer; and Edward J. Wellauer, Director of Research and Devel-

Continued on page 14

Acme Chain picks western distributor

J. W. Minder is now industrial distributor for Acme products on the west coast. A complete stock of roller chains and accessories will be stocked from Minder's branch in Portland, Oregon, as well as from the firm's Los Angeles, Cal., warehouse at 6011 South Central Ave., in that city.

Republic ups Henke

Robert H. Henke is the new assistant manager of Republic Steel Corp.'s central alloy district (Canton and Massillon, Ohio). He was manager of quality control at Allegheny Ludlum Steel Corp.'s Brackenridge, Pa., Works.

Worthington promotes Murray and Case

E. A. Murray is manager of the newly combined Sales and Service unit at The Worthington Corp., Compressor and Engine Division, at Buffalo, New York. Since 1951 Murray was manager of Compressor Sales.

Replacing him in this capacity is Everett L. Case. Sales and Service at the Buffalo Compressor and Engine Division have been combined.

Murray has a B.S. in Mechanical Engineering from Yale University. He joined Worthington in 1935. He is on the Executive Committee of the Compressed Air and Gas Institute, is a member of the Engineering Society of Buffalo.

Case has a B.A. degree from Canisius College and a B.S. degree from the University of

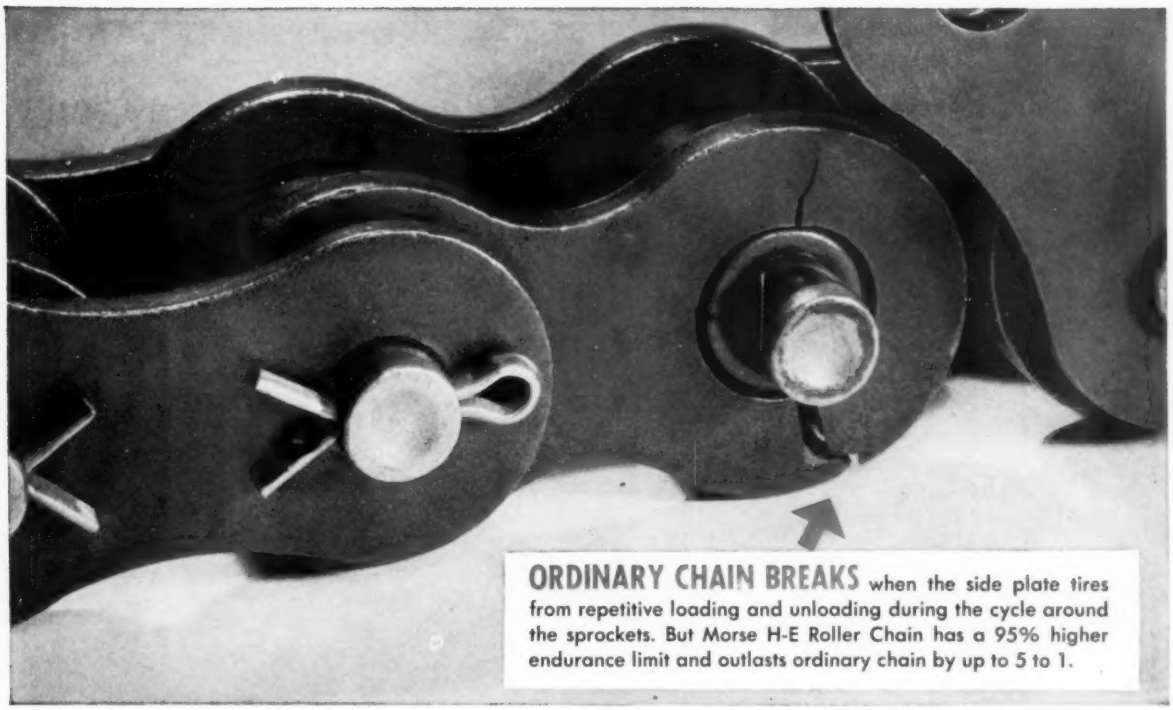
Murray

Case

Buffalo where he did graduate work in thermo-dynamics. He joined Worthington in 1937.

Heads SKF division

F. Harold Williams is now general manager of the newly created Hornell, N. Y., Div., SKF Industries Inc., a plant formerly operated as a unit of SKF's Mfg. Div. Williams was manager, Railway Sales Dept.



ORDINARY CHAIN BREAKS when the side plate tires from repetitive loading and unloading during the cycle around the sprockets. But Morse H-E Roller Chain has a 95% higher endurance limit and outlasts ordinary chain by up to 5 to 1.

"Tired Metal"... the bane of chain now licked by MORSE H-E

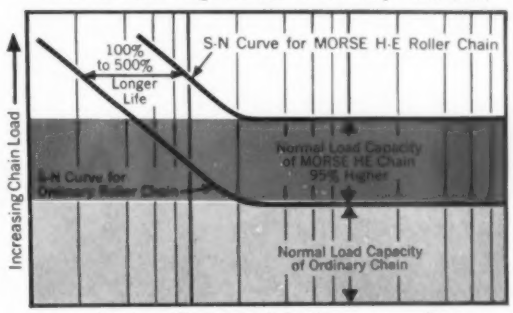
Morse H-E Roller Chain has up to 500% longer service life . . . cuts replacement and labor costs

The unretouched photograph shows what happens to chain when the metal fatigues. But now a special Morse process has licked the "tired metal" problem. It gives Morse H-E Roller Chain 95% higher endurance limit . . . and up to 500% longer service life.

The special process means Morse H-E Chain costs about 10% more. But that's a small price to pay for a heavy-duty chain that can save you thousands of dollars annually in replacement costs, downtime, and wasted man-hours.

For more information on the chain that licked the "tired metal" problem once and for all, see your local Morse Distributor. Or write: MORSE CHAIN COMPANY, Dept. 27-39, Ithaca, New York. Export Sales: Borg-Warner International, Chicago 3, Illinois.

Chain Life: Morse High Endurance vs. Ordinary Roller Chain


100% to 500% Longer Life
S-N Curve for MORSE H-E Roller Chain
Normal Load Capacity of MORSE HE Chain 95% Higher
S-N Curve for Ordinary Roller Chain
Normal Load Capacity of Ordinary Chain
S (stress)
Increasing Chain Load
Number of Times Load is Applied
N (number of cycles)

Red area: Under these chain loads, fatigue will break ordinary chain . . . but *not* Morse H-E.

White area: Under these loads, fatigue will break ordinary chain and Morse H-E . . . but Morse H-E will have operated 100% to 500% longer.

MORSE*

*Trademark

MORSE BW BORG-WARNER

A BORG-WARNER INDUSTRY

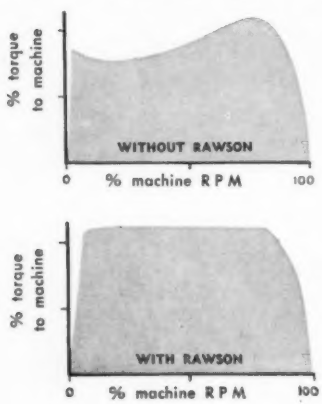
REMEMBER: Only Morse offers you all four of these basic drives: Roller Chain, Silent Chain, Hy-Vo®, and "Timing"® Belts.

For more information circle No. 44 on the Reader Service Card

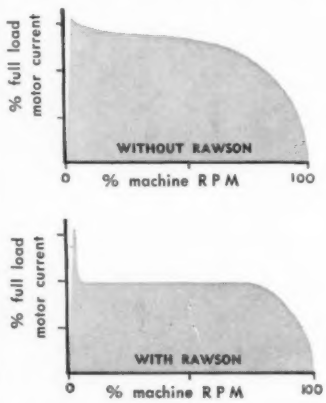
For Cushioned

How Rawson Improves Motor Performance

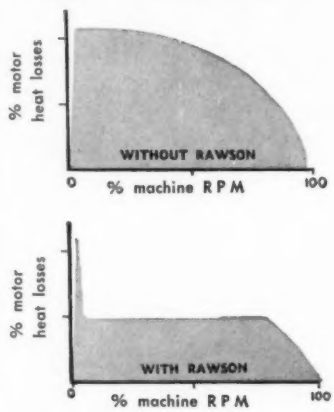
delivered starting torque



motor starting current



motor heat losses



For more information circle No. 20 on the Reader Service Card

"no load" Starts

Specify Rawson

Automatic Centrifugal Clutches and Clutch Couplings

Here is a major break-through in the development of automatic centrifugal clutches and clutch couplings! Rawson clutches and clutch couplings are designed with patented, exclusive metallic friction shoes instead of using fluid coupling devices or "brake lining" type materials. They deliver 100% slip-free power, provide full overload protection, permit smooth and gradual starting of high inertia equipment. This eliminates the need for costly special high torque starting motors and low-voltage starting equipment.

The segments, or shoes, in Rawson clutches and clutch-couplings are free-moving parts. As the driving half of clutch picks up speed, centrifugal force causes the shoes to contact the inside surface of the outer race, which is attached to the load or driven equipment. The shoes slip momentarily until friction at full speed causes the driven half to rotate in complete engagement with the driving half, both members then rotating as a unit without slippage or power loss. Jamming or overload of driven equipment causes clutch to slip — protecting motor against excessive overloading.

Rawson clutches and couplings drive in either direction and transmit up to 2,000 H.P. from nearly every motive source including A.C. and D.C. motors, diesel and gasoline engines or turbines. They function as direct couplings or as indirect drives through V-belts, chains or gearing and can be furnished with delayed shoe engagement for standby or dual drive units with load limit on starting or running. Rawson clutches and couplings are simple in design, fast and easy to install, entirely mechanical for trouble-free operation and they never require adjustment.

For increased efficiency, lower first costs, reduced maintenance and utmost protection even for the most delicate driving and driven equipment, specify Rawson clutches and clutch couplings. Ask your Rawson distributor or write us direct for your free copy of Rawson Catalog No. 141.

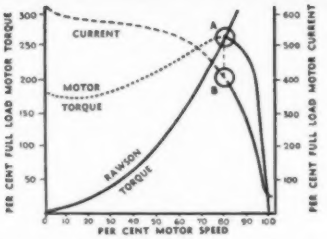
FORMSPRAG COMPANY
23587 Hoover Road, Dept. 101
Warren (Detroit), Michigan

Distributorships available in selected areas. Write for details.

FORMSPRAG COMPANY

World's Largest Exclusive Manufacturer of Over-running Clutches

and Protects Motors

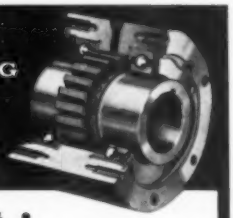


Using Rawson clutches or clutch couplings in a start-drive system lets you switch from costly high-torque motors to smaller standard, general-purpose motors for starting high-inertia loads.

Chart above shows how Rawson permits a standard NEMA "B" motor to start without load. The clutch does not fully engage until peak motor torque speed (A) is reached. Motor acceleration time is cut to a fraction of a second, decreasing the peak current period and allowing more efficient motor operation (B).

Thus, expense of reduced-voltage equipment is eliminated with the Rawson cushioned "no-load" starts, even on the heaviest machinery.

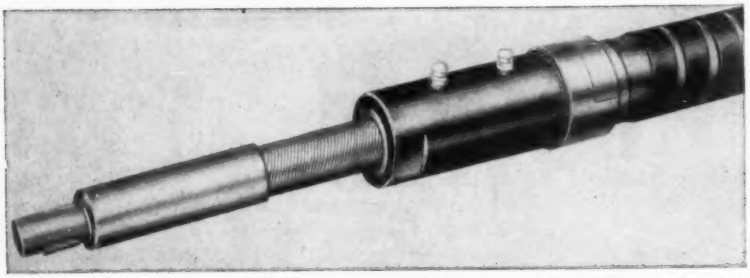
FORMSPRAG OVER-RUNNING CLUTCHES . . . UNIVERSAL APPLICATION!



OVER-RUNNING • INDEXING • BACKSTOPPING

Modern Formsprag sprag-type clutches are practically unlimited in power transmission applications. They are universally used in automotive, aircraft and general industries. Complete range of capacities from small clutches at 50 in. lbs. to large bore backstops up to 136,000 ft. lbs. Complete Formsprag standard line includes bore sizes from ⅜" to 12". Specials engineered to your requirements. Write for the new Formsprag catalog.

HOW TO SELECT FLEXIBLE SHAFTING FOR POWER DRIVE APPLICATIONS



1¼-inch STOW Power Drive flexible shaft with core assembly pulled out of casing.

For Power Drive applications, the following factors must be considered:

1. **Torque (Lb. In.)** to be transmitted (The starting torque should be used in making selections.)

2. **Operating Speeds (RPM)** — If the maximum speed is higher than the rated speed, torque ratings in the table below do not apply. To find the torque capacity for flexible shafts operating at speeds higher than the rated speeds, multiply the maximum dynamic torque capacity by the rated speed, and then divide by the operating speed. (See example.)

3. **Operating Radius** — In making the selection from the table below, the radius of the smallest bend in the flexible shaft should be used.

Ratings — The ratings for flexible shafts shown in the table below apply under the following conditions:

1. When the flexible shaft is adequately supported by clamps along its length (For unsupported shafts, multiply the calculated torque by a safety factor of 1.6—see example below.)

2. When the flexible shaft is operated in the wind-up direction, which tends to tighten the outer layer of wires. (Flexible shafts operated in the unwind direction will transmit only about 60% of the rated torque.)

3. When the flexible shaft is in continuous operation. Note: **the ratings are based on temperature rise. When the operation is intermittent, the ratings in the table may be exceeded. Consult Stow engineers for specific recommendations.**

RATED SPEED R.P.M.	MAXIMUM DYNAMIC TORQUE CAPACITY (LB. IN.) STRAIGHT AND CURVED SHAFTS RADIUS OF CURVATURE IN INCHES									Wgt./ C. Ft.	Core Dia.	Core No. and Type	Shaft Size
	50 to Strgt.	25	20	15	12	10	8	6	5				
4,500	2.4	2.2	2.0	2.0	1.92	1.9	1.7	1.5	1.25	3.0	.124/.128	2049 MH	13
3,800	7.0	6.4	6.0	5.8	5.4	5.0	4.6	3.6	2.0	4.5	.148/.152	2081 MH	15
2,900	9.4	8.6	8.0	7.6	7.0	6.6	6.0	4.8	3.4	7.0	.185/.189	5108 MH	19
2,500	22.0	20.0	18.8	17.6	16.0	15.0	12.6	10.8	9.0	12.5	.247/.252	8924 MH	25
1,800	30.0	28.0	26.4	25.0	23.0	21.0	18.0	14.0		20.0	.308/.313	8925 MH	31
1,800	33.8	31.5	29.7	28.1	25.9	23.6	20.2	15.8		20.0	.308/.313	8969 T	31
1,800	36.0	33.0	31.6	30.0	28.0	26.0	22.0	18.0	11.0	21.0	.324/.329	2034 A	31
1,500	80.0	66.0	63.0	58.0	51.0	46.0	37.0	22.0		28.5	.368/.374	2035 A	38
1,500	60.0	54.0	50.0	46.0	42.0	38.0	30.0	24.0		29.0	.387/.393	8970 MH	40
1,500	90.0	81.0	75.0	69.0	63.0	57.0	45.0	36.0		29.0	.387/.393	8971 T	40
1,150	136.0	110.0	104.0	94.0	80.0	72.0	56.0			50.5	.497/.503	8999 A	50
1,150	148	124	110	92	72	56				53.5	.505/.511	6940 T	50
900	248	200	176	124	84					78.5	.610/.618	6997 T	63
900	220	204	192	180	152	130				80.5	.630/.638	7731 A	63
750	340	224	156	76						117	.747/.753	2056 T	75
600	760	520	420							205	.998/1.004	2057 T	100
440	1,500	720								343	1.298/1.304	2058 T	125

EXAMPLE: How to use the table:
The problem is to transmit ½ HP at 1700 RPM through an unsupported flexible shaft in a 25" radius estimated starting torque. 150% of normal operating torque.

1. Calc. Torque (lb. in.) —
$$\frac{HP \times 03000}{RPM} = \frac{.5 \times 63000}{1700} = 18.5$$

2. Correction factor for starting torque $1.5 \times 18.5 = 27.75$

3. Correction factor for unsupported shaft $27.75 \times 1.6 = 44.4$ lb. in.

4. Refer to Table above. Read downward in column under 25" radius until you find a core having a rating of at least 44.4 lb. in. In this case we find that core No. 8970 is rated 54 lb. in. at 1500 RPM. Since the given speed is 1700 RPM, multiply 54 by 1500 and divide by 1700. $54 \times 1500 \div 1700 = 47.6$ lb. in. (rated torque at 1700 RPM). Therefore, Core No. 8970 is correct.

For Engineering Bulletin No. 570 and a free torque calculator, write

STOW MANUFACTURING COMPANY

440 Shear Street Binghamton, New York

For more information circle No. 63 on the Reader Service Card

MEN *continued from page 10*

opment. Walter P. Schmitter assumes the position of Vice President of Engineering. He will be responsible for engineering planning and policy.

Formerly Assistant Chief Engineer of Gear Technology and Industrial Gearing, Maurer started with Falk in 1926. He has a degree in Electrical Engineering from Marquette University.

He is a member of the AGMA Board of Directors, being chairman of the Tooth Committee. He is a member of the National Society of Professional Engineers, the Engineers Society of Milwaukee, and the Wisconsin Board of Registered Architects and Professional Engineers.

Richardson, a mechanical engineering graduate of the University of Wisconsin, joined Falk in 1937. He is a member of the Society of Naval Architects, and the Society of Naval Engineers.

Wellauer, electrical engineering graduate of Marquette, has a Master of Science degree from the University of Wisconsin. He became an engineer at Falk in 1938. He is a member of AGMA, ASME, American Society for Metals, Society for Experimental Stress Analysis, American Institute of Mining and Metallurgical Engineers, and the National Society of Professional Engineers.

Sands G. Falk, formerly Manager of Marketing Research, is now Eastern Regional Sales Manager of the Falk Corp. He replaces H. Douglas Stier of New York City who retired. His headquarters will be in Milwaukee.

Kenneth O. Hood will take charge of the new Midwestern Region with headquarters also in Milwaukee.

General Higgins At Dayton Rubber Co.

Major General Gerald J. Higgins is now Assistant to the President on military matters for The Dayton Rubber Company it was recently announced.

General Higgins was graduated from West Point Military Academy in 1934. Ten years la-

Continued on page 36

STEPHENS-ADAMSON

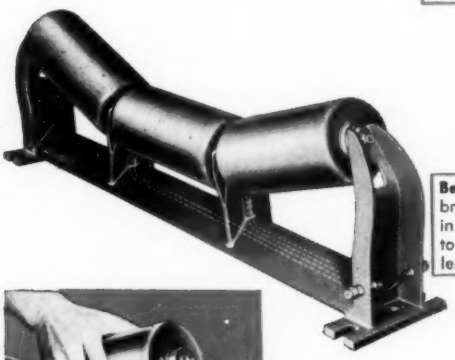
PROVES IT'S WHAT'S UNDER THE BELT THAT COUNTS IN PROFITABLE CONVEYING

S-A CARRIERS

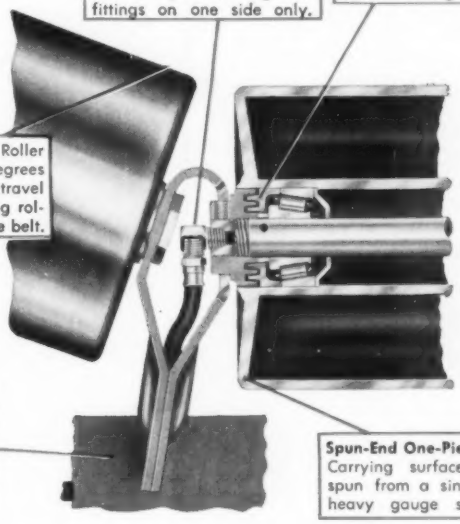
Interchangeability — Roller assemblies and parts for all three rollers are interchangeable.

Positive Lubrication — Each roller assembly pre-lubricated, with an alemite fitting for field lubrication. Lubrication kits can be furnished to provide all grease fittings on one side only.

Labyrinth Seals — Bearings are protected by a die-cast labyrinth seal. Keeps grease in, dust and dirt out. Featured on both S-A Ball and Roller Bearing Carriers.



Belt Training — Roller brackets tilt two degrees in direction of belt travel to aid the troughing rollers in centering the belt.



"Lift-Out" Feature — Pre-adjusted individual rollers can be easily slid in or out. Provides for fast roller changes without the use of tools. Rollers will not fall out during actual use.

Rugged Frame Construction — One piece, all-steel, welded frame features inverted angle cross members and outer brackets designed to prevent spillage from collecting.

Spun-End One-Piece Rollers — Carrying surface and ends spun from a single piece of heavy gauge steel tubing.

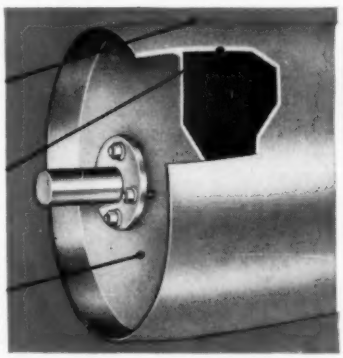
CURVE CROWN BY STEPHENS-ADAMSON

WELDED ALL-STEEL **PULLEYS**

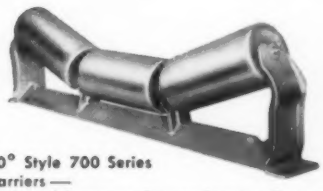
CURVE CROWN DESIGN
CURVE CROWN on outer ends of rim accurately formed. Eliminates belt stretch and wear — while increasing belt training effect more than 100%.

STURDY RIM CONSTRUCTION
One piece rims formed absolutely round under hydrostatic pressure. Machine-welded inside and out to insure 100% penetration.

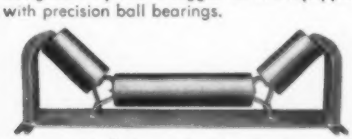
ACCURATE END PLATE ASSEMBLY
O.D. and I.D. of end plates machined to insure concentricity. They are pressed into position for tight fit-up — submerged arc-welded for maximum efficiency.



"SQUEEZELOCK" HUB
Provides gripping power for full torque transmission **without use of keyways** and eliminates distorting loads against pulley end plates.



20° Style 700 Series Carriers —
Designed for years of rugged service. Equipped with precision ball bearings.



35° and 45° Deep Trough Carriers — for handling grain, chips or similar materials. Equipped with precision ball bearings. Three equal roller design also available.

Rubber Disc or Pneumatic "Impact" Carriers —
for use under loading spouts in belt conveyors, feeders and shuttle conveyors to cushion the lumps.

Write for:
CARRIER Bulletin 355
PULLEY Bulletin 558

Stocked for Immediate Shipment

S-A

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STEPHENS-ADAMSON MFG. CO.
GENERAL OFFICE & MAIN PLANT, 71 RIDGEWAY AVENUE, AURORA, ILLINOIS
PLANTS LOCATED IN: LOS ANGELES, CALIFORNIA • CLARKSDALE, MISSISSIPPI
BELLEVILLE, ONTARIO

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EVERY TYPE OF CUT GEAR FOR EVERY INDUSTRIAL PURPOSE

SINCE 1888... We have been making many types and sizes of gears for industry. During these passing years we have derived considerable experience, trained numerous personnel, and expanded our mechanical and plant facilities—and have remained under one continuous management. We are ready to ably serve you.

ESTABLISHED 1888
D.O.James

D. O. JAMES GEAR MANUFACTURING CO.
1140 W. Monroe Street, Chicago 7, Ill.

Already in preparation are important articles for PTD's readers . . .

David R. Cartwright
editor

What's coming next month For Power Transmission Design readers?

Ever hear of a modular drive?
Next month we'll show how a machine tool manufacturer designed a series of basic machine beds for interchangeable selection with a series of basic change gears and drive units. Now, customers can select their own kind of machine from the basic elements available. Specific speed ranges, type of drive—whether mechanical or electrical—speed control are all selectable from the components. This is an idea that could apply to any drive system. Don't miss it next month.

75,000 ft at 2000 mph. . . .
. . . is a lot of airplane. Next month we'll show you how a punched tape system positions two shafts automatically to weld the stainless steel skin of this fast supersonic aircraft. It will give you ideas for your own use. This machine has two lead screws that are powered and minutely positioned from the tape signals. The tape controls a hydraulic servo valve that vents oil to a hydraulic motor. The tape causes the oil to vent to one or the other side of the motor causing it to rotate in left or right direction. When the servo valve reaches null, the motor stops. Thus, tape signals control final position by controlling shaft rotation. This, next month in POWER TRANSMISSION DESIGN.

What are critical speeds?
Do your machines vibrate or, at certain speeds, is there noise and chatter? If so, the drive components may be out of balance causing undesirable critical speeds. Worse yet, if your speed range is high, the drive may display harmonic vibrations which are multiple effects of the initial critical speed. Critical speeds are caused by unbalance of basic parts. These parts can be out of balance a little or a lot, either statically or dynamically. It does not take an expert to solve this problem—if you know what to look for. Don't miss critical speeds next month.

When should you use Silent Chain
What is it and how do you apply it? It's surprising how little designers and plant engineers know about silent chain. Too often it takes the backseat to other driving methods. It consists of a series of toothed-link plates that articulate as they pass over the sprocket; and it does a good job. See more about silent chain next month.

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How to select a roller chain drive

SELECTING A ROLLER chain drive means chiefly, selecting the correct chain and sprockets for the right job. This includes selecting the right chain-length and center distance, and deciding what type lubrication should be used.

Before you start, know how much horsepower you want to transmit, speeds and sizes of your shafts, space limitations, environmental conditions and hours of continuous operation.

Horsepower is not the only important factor. Dust, fumes, and extreme temperature will decide lubrication; speeds will decide chain pitch; shaft sizes will decide sprocket bore diameters, all of which are important.

If you end up applying a chain heavier than necessary, you will be "overchaining". This is costly. If you apply too-light a chain, you will be "under-chaining" and it will cause trouble.

Problem: let's select a typical roller chain drive . . .

. . . to transmit 10 hp from a counter-shaft to the main shaft of a wire drawing machine. The countershaft is 1-11/16 inch dia and operates at 1200 rpm. The main shaft is 1-15/16 inch dia and must operate between 378 rpm and 382 rpm. Shaft centers are fixed and are approximately 22½ inches apart. The load on the main shaft is uneven and has peak shock loads. The drive must run 10 hrs a day. The driving head is fully enclosed and protected and all parts are lubricated from a central system providing good lubrication.

Solution: here are the steps you should follow . . .

Step 1: Select Load Type And Service Factor.

Load Classification	Type of Load	Service Factors	
		10-Hr Day	24-Hr Day
A	Uniform	1.0	1.2
B	Moderate Shock	1.2	1.4
C	Heavy Shock	1.4	1.7

You can see from the table that the load classification is type C and the service factor is 1.4.

Step 2: Select Design Horsepower

Multiply the specified horsepower by the service factor from step 1 to obtain the design horsepower.

design hp = 10 × 1.4 = 14 hp

Step 3: Select Possible Chain And Small Sprocket

Refer to the horsepower-rating chart on the next page. Look opposite 14 hp and 1200 rpm. You will cross at #60 chain with ¾-in pitch operating over a 19-tooth sprocket.

There will be times when you will have more than one selection. Evaluate the alternatives accordingly.

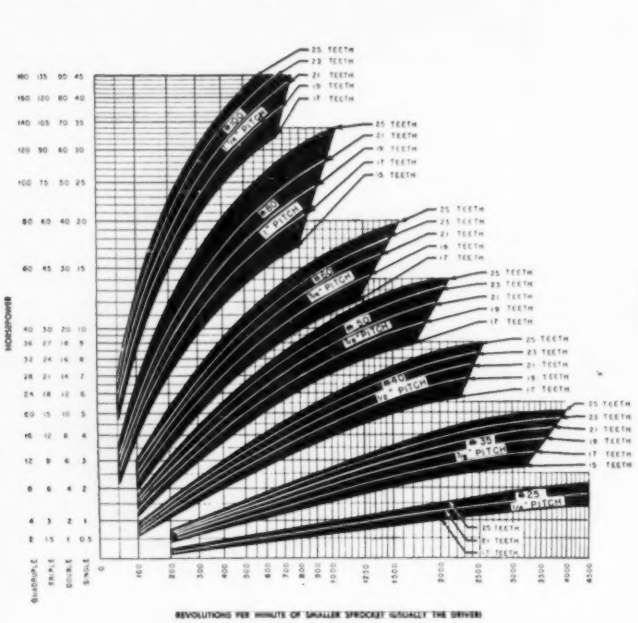
Step 4: Check Chain And Small Sprocket

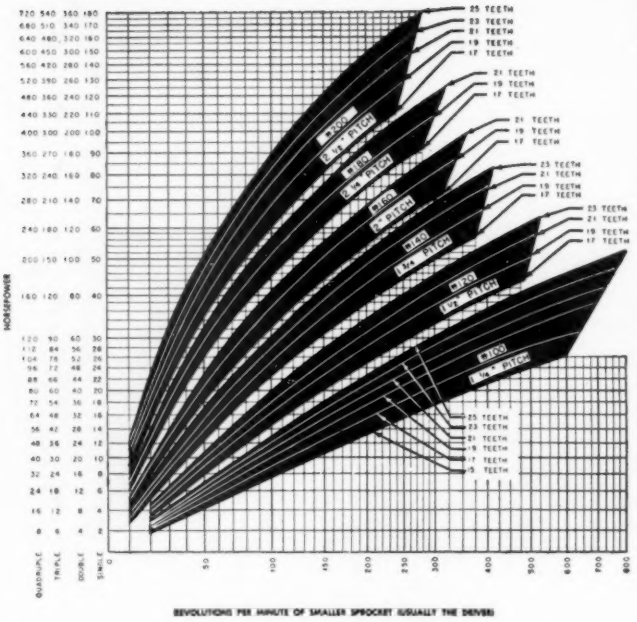
Refer to any roller chain horsepower rating table such as in the Design Manual of Roller and Silent Chain Drives, Machinery's Handbook or any other reference book with chain data. These tables are not shown in this article so we'll double check this data for you. The tables show that for a #60 chain, ¾-in. pitch chain at 1200 rpm; hp = 13.87 which is within 99% of our computed design hp above and is therefore adequate.

To determine the maximum sprocket bore,

Continued on next page

THIS ARTICLE is adapted from the new Design Manual, 'Roller and Silent Chain Drives'. For a review of this work, see 'Books'.





refer to the table at the bottom of this page. You will see that for a 19 tooth sprocket, ¾-in. pitch; maximum bore size = 2-7/16 in. This is sufficiently larger than required. If a larger sprocket is required, re-check the chain pitch by reference to the rating chart and tables.

Step 5: Select Large Sprocket

Compute the number of teeth for the large sprocket using the selected small sprocket and the specified shaft speed ratio. If the required speed ratio cannot be obtained with an integral number of teeth on the large sprocket, try a larger size small sprocket.

Since the driver sprocket operates at 1200 rpm, and the driven sprocket at 378 rpm

speed ratio =

$$\frac{1200}{378} = 3.175$$

Therefore the large sprocket should have

$19 \times 3.175 = 60.325$ teeth.

Use a 60 tooth sprocket.

This combination of 19 and 60 teeth will produce a main drive shaft speed of 380 rpm which is within the limitations of 378 to 382 established.

Now check space limitations. If it is found that there is not enough room for the 19 or 60 tooth sprockets, a multiple chain must be selected.

Looking down the 1200 rpm line again, a

No. of Teeth	⅜" Pitch		½"		⅝"		¾"		1"	
	Max. Bore	Maximum Hub Dia.	Max. Bore	Maximum Hub Dia.	Max. Bore	Maximum Hub Dia.	Max. Bore	Maximum Hub Dia.	Max. Bore	Maximum Hub Dia.
11	19/32	55/64	25/32	1 11/64	31/32	1 15/32	1¼	1 49/64	1⅝	2⅜
12	⅝	63/64	⅞	1 21/64	1 5/32	1 43/64	1 9/32	2 1/64	1 25/32	2 45/64
13	¾	1 7/64	1	1½	1 9/32	1⅞	1½	2¼	2	3 1/64
14	27/32	1 15/64	1 5/32	1 21/32	1 5/16	2 5/64	1¾	2½	2 9/32	3 11/32
15	⅞	1 23/64	1¼	1 13/16	1 17/32	2 9/32	1 25/32	2¾	2 13/32	3 43/64
16	31/32	1 15/32	1 9/32	1 63/64	1 11/16	2 31/64	1 31/32	2 63/64	2 23/32	3 63/64
17	1 3/32	1 19/32	1⅜	2 9/64	1 25/32	2 11/16	2 7/32	3 7/32	2 13/16	4 5/16
18	1 7/32	1 23/32	1 17/32	2 19/64	1⅞	2 57/64	2 9/32	3 15/32	3⅛	4 41/64
19	1¼	1 27/32	1 11/16	2 29/64	2 1/16	3 5/64	2 7/16	3 45/64	3 5/16	4 61/64
20	1 9/32	1 61/64	1 25/32	2⅜	2¼	3 9/32	2 11/16	3 61/64	3½	5 9/32
21	1 5/16	2 5/64	1 25/32	2 25/32	2 9/32	3 31/64	2 13/16	4 3/16	3¾	5 19/32
22	1 7/16	2 13/64	1 15/16	2 15/16	2 7/16	3 11/16	2 15/16	4 7/16	3⅞	5 59/64
23	1 9/16	2 5/16	2 3/32	3 3/32	2⅝	3 57/64	3⅛	4 43/64	4 3/16	6 15/64
24	1 11/16	2 7/16	2¼	3 17/64	2 13/16	4 5/64	3¼	4 29/32	4 5/16	6 9/16
25	1¾	2 9/16	2 9/32	3 27/64	2 27/32	4 9/32	3⅜	5 5/32	4 11/16	6⅞

double-strand, #50 chain would also have adequate capacity. Since only 14 hp is needed, a 17 tooth, #50, 2-strand would be adequate since it is rated at 15 hp (7½ hp per strand).

Chains of still smaller pitch and wider multiples could also be used, but the largest-pitch chain with the fewest strands is usually the least expensive and therefore the best choice.

Step 6: Compute Chain Length

Since the computed length may be fractional, a chain consisting of an integral number of pitches should be used. The next even number of pitches is preferable over an odd number since the latter would need an offset link.

Since 19 and 60 tooth sprockets are to be placed on 22½ in. centers, determine chain length as follows

$$L = 2C + \frac{N+n}{2} + \frac{(N-n)^2}{4\pi^2 C}$$

Where

L = chain length in pitches
C = shaft centers in pitches
N = number of teeth in large sprocket
n = number of teeth in small sprocket

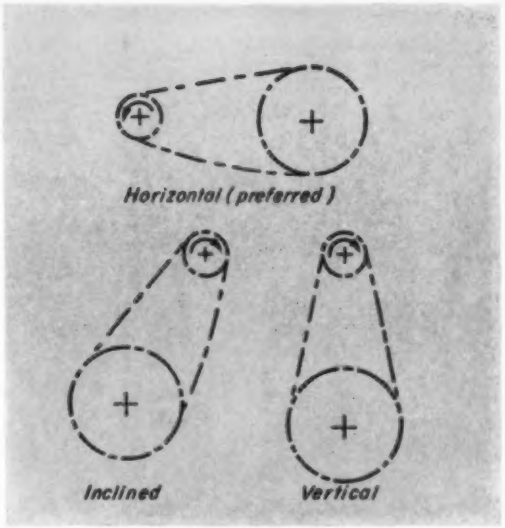
Substituting values for C, N and n

$$L = 2 \times 30 + \frac{60+19}{2} + \frac{(60-19)^2}{39.48 \times 30}$$
$$= 100.92$$

Step 7: Correct Center Distance

Using the adopted length, recompute center distance. If center distance is fixed and the adopted length causes an objectionable slack, an idler may be used, or a sprocket combination that will provide a snug fit without objectionable slack.

Since the chain is to couple at an even number of pitches, we will use 100 pitches and recompute the exact centers in pitches



RELATIVE SHAFT POSITIONS for applying roller chain drives properly.

$$C = \frac{L - \frac{N+n}{2} + \sqrt{\left(L - \frac{N+n}{2}\right)^2 - 8\frac{(N-n)^2}{4\pi^2}}}{4}$$

$$= \frac{100 - \frac{60+19}{2} + \sqrt{\left(100 - \frac{60+19}{2}\right)^2 - 8\frac{(60-19)^2}{39.48}}}{4}$$

C = 29.525 pitches
= 22.14 in.

Conclusion

Since the #40-3 drive considered initially could not be tailored to meet the shaft requirements, final selection is 19 and 60 tooth sprockets mounted on 22.14 in. centers using #60, ¾ in. pitch chain.

On checking against horsepower rating tables (Design Manual, Roller and Silent Chain; Machinery's Handbook) for #60 chain; type II lubrication is indicated. The central system of lubrication in this example meets this requirement.

No. of Teeth	1¼"		1½"		1¾"		2"		2½"	
	Max. Bore	Maximum Hub Dia.	Max. Bore	Maximum Hub Dia.	Max. Bore	Maximum Hub Dia.	Max. Bore	Maximum Hub Dia.	Max. Bore	Maximum Hub Dia.
11	1 31/32	2 31/32	2 5/16	3 37/64	2 13/16	4 11/64	3 9/32	4 25/32	3 15/16	5 63/64
12	2 9/32	3 3/8	2 3/4	4 1/16	3 1/4	4 3/4	3 5/8	5 27/64	4 23/32	6 51/64
13	2 17/32	3 25/32	3 1/16	4 35/64	3 9/16	5 5/16	4 1/16	6 5/64	5 3/32	7 39/64
14	2 11/16	4 3/16	3 5/16	5 1/32	3 7/8	5 7/8	4 11/16	6 23/32	5 23/32	8 27/64
15	3 5/32	4 19/32	3 3/4	5 33/64	4 7/16	6 29/64	4 7/8	7 3/8	6 1/4	9 7/32
16	3 9/32	5	4	6	4 11/16	7 1/64	5 1/2	8 1/64	7	10 1/32
17	3 21/32	5 13/32	4 15/32	6 31/64	5 1/16	7 37/64	5 11/16	8 21/32	7 7/16	10 27/32
18	3 25/32	5 51/64	4 21/32	6 31/32	5 5/8	8 3/64	6 1/4	9 5/16	8 1/8	11 41/64
19	4 3/16	6 13/64	4 13/16	7 29/64	5 11/16	8 45/64	6 7/8	9 61/64	9	12 7/16
20	4 19/32	6 39/64	5 7/16	7 13/16	6 1/4	9 17/64	7	10 19/32	9 3/4	13 1/4
21	4 11/16	7	5 11/16	8 27/64	6 13/16	9 53/64	7 3/4	11 15/64	10	14 3/64
22	4 7/8	7 13/32	5 7/8	8 57/64	7 1/4	10 25/64	8 3/8	11 7/8	10 7/8	14 27/32
23	5 9/16	7 13/16	6 3/8	9 3/8	7 7/16	10 15/16	9	12 35/64	11 5/8	15 21/32
24	5 11/16	8 13/64	6 13/16	9 55/64	8	11 1/2	9 5/8	13 3/32	13	16 29/64
25	5 23/32	8 39/64	7 1/4	10 11/32	8 9/16	12 1/16	10 1/4	13 51/64	13 1/2	17 1/4

After you have decided what type reducer you need, based on the best hardware available to do the best job, consider what it will cost you. But beware. Cost factors alone are not a main criterion for decision.

Consider these cost factors when selecting right angle reducers

By WILLIAM A. WILLIAMS, Consulting Editor

THERE IS A WIDE DIFFERENCE in initial cost among reducers, much as there is with other products. Sometimes initial cost is important, sometimes not. To some, it is the least important factor, especially when service, maintenance, performance and adaptability are given prior consideration.

Let's examine some of these factors: There are two basic types of reducers for right angle applications—worm and spiral bevel. Of the worm, there are two basic types: standard-straight, called single-enveloping; and hour-glass, called double-enveloping.

Both types of worm reducers are made with or without built-in fans for cooling. When operated at motor input speed, the fan-cooled unit produces a great saving. Without fans, conventional worm reducers must be excessively large, when run at high input speed, to provide housing enough to radiate the heat away and keep oil temperature down. Water cooling also permits reduction in size.

Of the spiral-bevel type, all are single-reduction up to ratios of 8 or 9 to one. For higher ratios, standard-helical gears are used along with the right-angle gearset.

ABOUT THE AUTHOR

Williams, nationally known authority on machine drives, is holder of more than 30 patents in the power transmission field. He is a professional consultant to industry and the author of Mechanical Power Transmission Manual.

Having decided that a right angle reducer is needed, you must decide which one of several types is the best buy.

To do this the following factors need to be considered: first cost; comparative operating cost based on reducer efficiency and hours of operation per year; noise; bulk and weight; shock capacity.

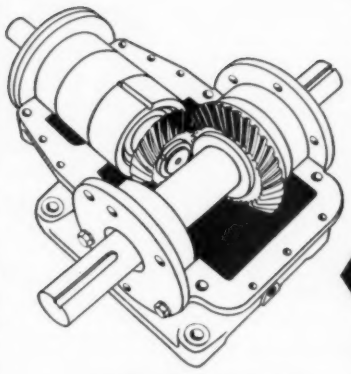
The reason for the cooling problem in worm reducers is the relatively low efficiency of worm gearing as compared with spiral-bevel and helical. Spiral-bevel and helical reducers, because of their high mechanical efficiency, seldom have a heat problem.

An example of reducer selection analysis is shown in the table. Standard reducers are shown for three ratios with an input of 20 hp, 1750 rpm, class I, unity service factor which assumes no shock. For first cost, fan-cooled reducers in general are lowest. For weight, fan-cooled worm and spiral-bevel are about the same. Fan-cooled double-enveloping worm and spiral-bevel have about the lowest volume.

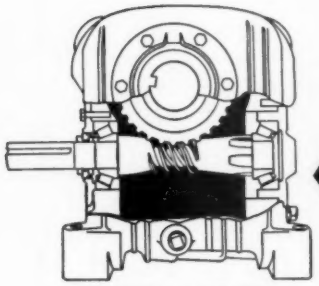
The fan-cooled double-enveloping worm is the lowest of all in first cost; the single-enveloping worm runs a close second. The question of operating cost is next, and this requires consideration of power cost and hours of operation per year.

Assume a power cost of $.015 per kilowatt-hour, and a cost of $.013 per input horsepower, worm reducers cost more than helical reducers in a 250 day year, 8 hour day by the amounts shown.

The helical reducer is used as the base level for comparison. The added cost is figured by assuming a constant input horsepower resulting in an error of some magnitude at high ratios.

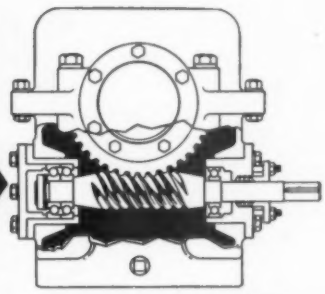


SPIRAL BEVEL REDUCER

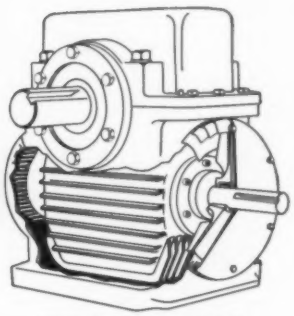


STANDARD DOUBLE-ENVELOPING WORM

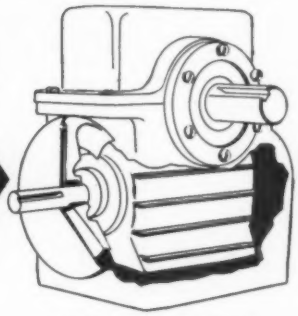
H.P.	RATIO	INPUT SPEED RPM	APPROX. CONSUMER PRICE	WEIGHT LBS.	VOLUME CU. IN.
20	10/1	1750	$727	700	7300
20	20/1	1750	1400	1650	21,000
20	30/1	1750	2483	3000	47,000
20	10/1	1750	994	430	6200
20	20/1	1750	994	430	6200
20	30/1	1750	1210	590	8870
20	10/1	1750	569	475	5050
20	20/1	1750	746	550	6150
20	30/1	1750	1003	900	10,350
20	10/1	1750	847	600	6900
20	20/1	1750	1200	810	9500
20	30/1	1750	1200	810	9500
20	10/1	1750	465	290	3050
20	20/1	1750	629	388	4300
20	30/1	1750	920	605	6900



STANDARD WORM REDUCER



FAN-COOLED, SINGLE-ENVELOPING WORM



FAN-COOLED DOUBLE-ENVELOPING WORM

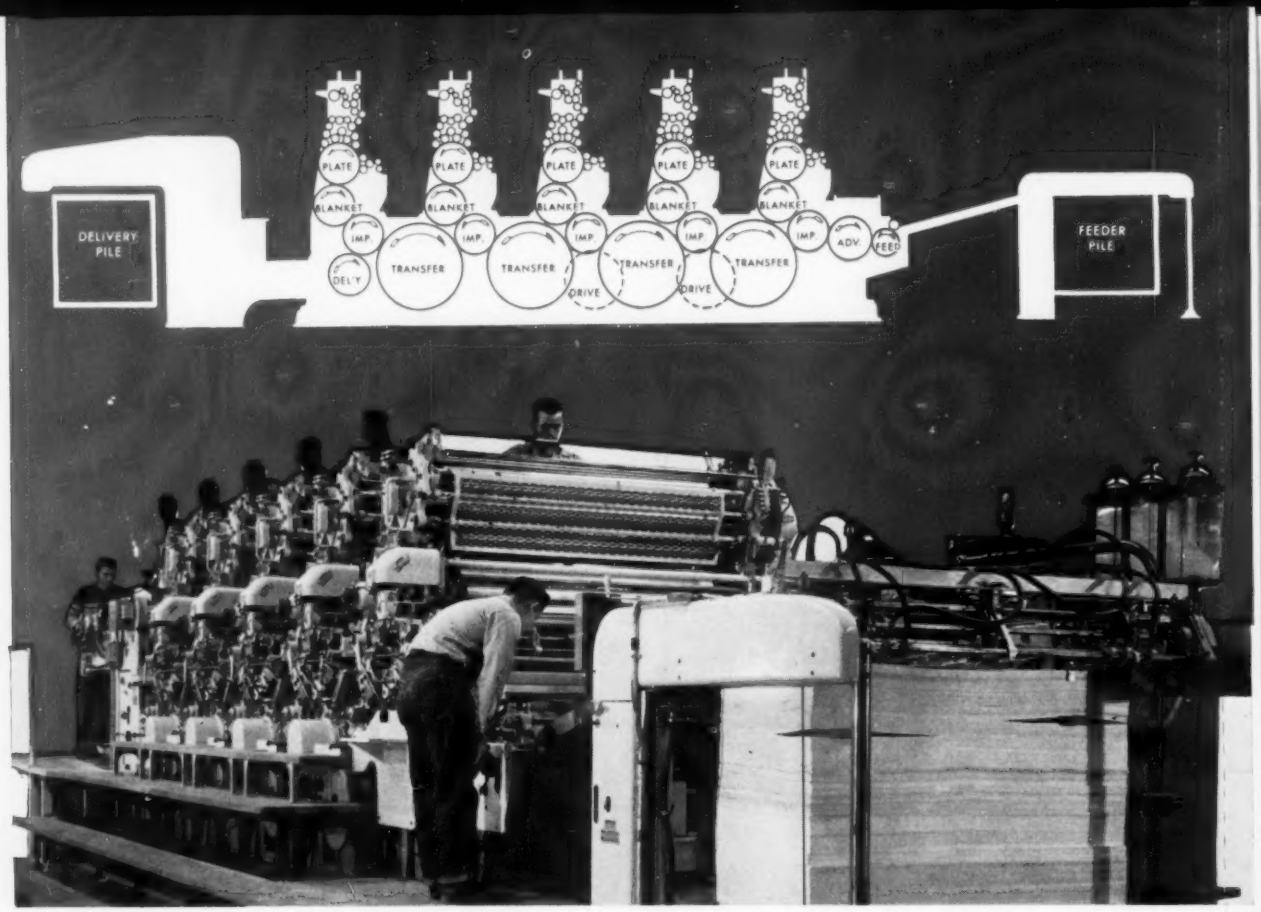
Changing the time period, of course, changes the answer. For example, a two or three shift operation favors the spiral bevel, and so does a 15-year estimated life instead of a 10-year life. The important point is that first cost does not always tell the whole story. Intermittent duty favors worm reducers because power cost is negligible.

About noise. The worm reducers are likely to be quieter than the spiral-bevel helical.

Bulk and weight definitely favor worm reducers. Shock capacity generally is inherently higher in worm reducers than in spiral bevel and helical, and this is shown by the comparative service factors recommended by the manufacturers. For high-shock applications the worm service factor is about 1.3, and spiral bevel-helical is about 1.75.

BEST BUYS FOR A 10 YEAR LIFE ARE

application	reducer	first cost	added power cost	total cost
20hp 10/1	fan-cooled double-enveloping	$465	$210	$675
20hp 20/1	spiral-bevel	994		994
	fan-cooled double-enveloping	629	360	989
20hp 30/1	spiral-bevel	1210		1210
	fan-cooled double-enveloping	1225	620	1225



FIVE-COLOR OFFSET PRESS has two d-c motors powered directly from dry rectifier a-c control circuit.

How to use d-c motors with a-c power

BY VICTOR N. YINGLING, project engineer Harris Seybold Co., Div. Harris Intertype Corp.

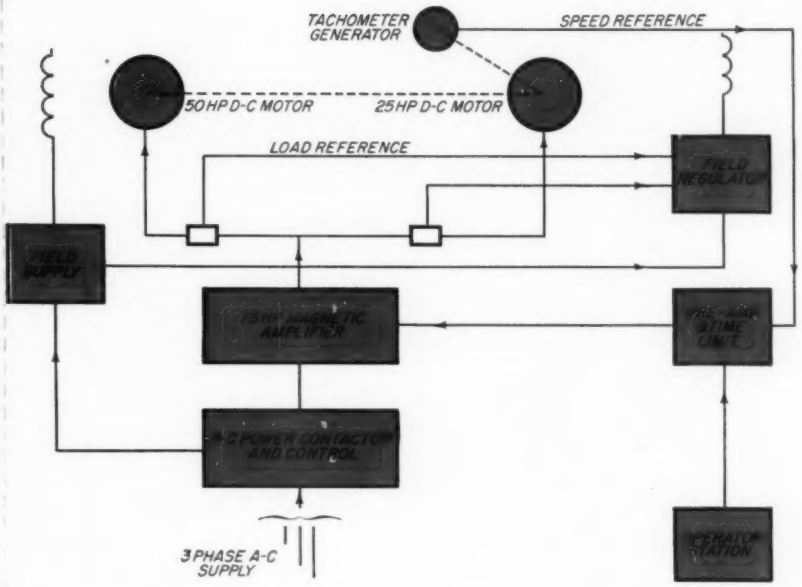
Load-balance circuit in static a-c to d-c drive system powers two different-size motors in the same gear train without backlash.

A NEW 5-COLOR OFFSET press has a completely automatic, stepless, speed control. It is powered by two d-c motors, 15 and 30 hp, connected to the gear train and powered directly from an a-c to d-c dry rectifier conversion unit. No rotating equipment, such as the motor-generator set recently replaced, is used.

Speed control is effected by varying the d-c voltage applied to the armatures of the two motors. The motors operate at the same speed, but being of different size, carry different amounts of load. They transfer power to common driving gears in the gear train and eliminate backlash in the same way two locomotives at the front of a long train prevent thumping of the cars as opposed to a front engine and a pusher at the rear.

The press weighs over 60 tons and prints five colors on flat sheets at the six different stations. It has two auxiliary, 5-hp motors at the feed and delivery stations. V-belt drives are used between the main motors and gear trains to transmit power smoothly, help damp shock and assure quietness of operation.

Feature 1: static drive eliminates motor-generator set



BLOCK DIAGRAM shows mag-amp circuit which eliminates need of m-g set by converting ac directly to dc.

No rotating equipment is used in the conversion of a-c to d-c power for the press. The conversion system is completely static and is called a magnetic amplifier control.

The circuit converts 3-phase a-c power directly to adjustable d-c voltage for both drive motors. The conversion is accomplished in a highly-efficient silicon rectifier circuit. The output voltage to the motors is controlled by saturable reactors. The combination of the rectifiers and reactors is known as the power mag-amp circuit.

The total speed range from creep to full speed is approximately 50 to 1. A tachometer generator, driven by the small motor, provides a speed signal which is fed back to the preamplifier. This is used to adjust the output voltage of the amplifier to maintain steady speed at all points within the operating range.

Time limit acceleration is controlled through an auto-transformer speed-reference powered by a pilot motor. Time limit control assures that the press will always accelerate at the same rate regardless of changes in load. Since both motors are connected to the load and operate at the same speed, it is necessary to have a way of assuring that they each carry their respective share without free-wheeling.

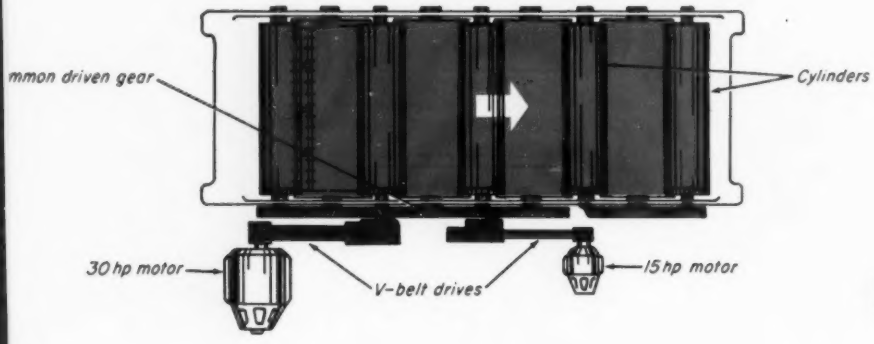
To do this, a field regulator, which supplies the small motor field, receives feedback current signals from both motors and adjusts the field strength of the smaller motor accordingly. This assures that the armature currents of both are always in load-balance.

To the operator, this system provides trouble-free performance with little maintenance downtime. Simple start-stop push button control, dial speed selection and high range of speed selection permit him to work at high production at all times.

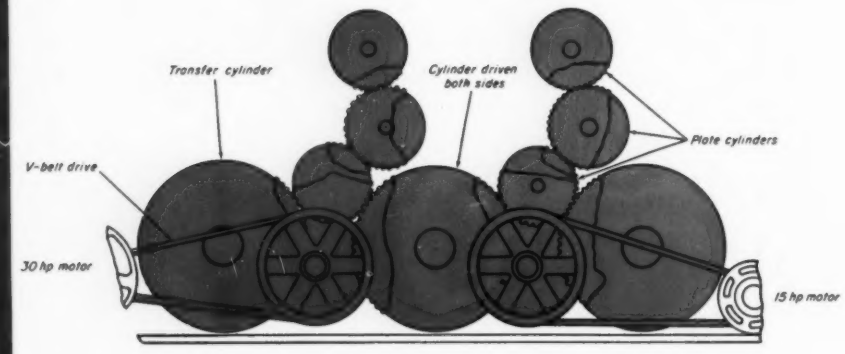
Optional features of the drive include dynamic braking, which eliminates external mechanical brakes; jogging for setup; and quick slowdown. Since there are no electronic components, such as in a straight tube control, complex maintenance by highly-trained specialists is not necessary. All operating parts are static. Elimination of the m-g set eliminates shafts, bearings and other mechanical components that require maintenance.

Continued on next page

Feature 2: two motors power gears without backlash



BOTH MOTORS operate at same speed, different torque. Larger motor controls backlash.



TWO MOTORS, 30 hp and 15 hp, mounted at different points, power press rolls with much less gear deflection than previously.

Instead of a single large drive motor previously used, two of different size are used to power the gear train and cylinders of all stations. One is 30 hp, the other 15 hp. They are both controlled from the dry rectifier circuit and always at identical speeds but with controlled load-balance.

Floating backlash, which would exist if the two motors were applied at remote stations, is eliminated by the way they are connected to the same gear train; and by the way the control circuit keeps the load division constant. Use of the two motors permits use of narrower faced gears and eliminates heavy stress concentrations formerly encountered when all torque was applied at one point from a single motor.

The two motors use less power than a single motor of the same total rating. The 30 hp motor does approximately twice the work that the 15 hp motor does and controls all backlash tendencies. Together, they produce less deflection on the shafts and gears, and less loading on the bearings, than a single motor.

They are connected by V-belts to pulleys attached to two adjacent transfer cylinders. Torque from the larger motor is applied to its cylinder first with respect to the direction of travel of the sheets passing through.

Conversely, the larger motor drives through the smaller motor in the same way that the first locomotive pulls through the second.

The two motors are mounted on the drive side of the press opposite the operator's side. During operation, sheets are fed, one at a time, from the feeder to the delivery side through the five stations.

The feed and delivery cylinders are approximately the same size and operate at the same speed since the gearing is interlocked to effect speed synchronization. This also permits transmission of power from the drive gears to the last printing station.

The feed and delivery cylinders at each station are approximately the same size and operate at the same speed since the gearing is interlocked to effect speed synchronization. This also permits transmission of power from the drive gears to the last printing station.

the most important advance in couplings since Sier-Bath's flangeless design!

new **nyflex**

Flexible Gear Couplings WITH NYLON SLEEVES

- No lubrication required
- Takes more misalignment than standard gear couplings
- Top performance in horizontal or vertical positions
- Weighs only 3½ pounds
- Low in price
- Speeds to 5000 rpm
- 1⅛" max. shaft capacity

ONLY 5 PARTS

Assembles, disassembles in seconds, no special tools needed!

This NYFLEX flexible gear coupling has a one-piece sleeve weighing only four ounces! The entire assembly, including high-strength steel hubs and retaining rings, weighs just 3½ pounds. It's the lightest, most compact flexible gear coupling you can buy. Another outstanding "first" from Sier-Bath, pioneer producer of flangeless, one-piece flexible gear couplings.

The NYFLEX coupling gives you several innovations in design and performance. It never needs lubrication . . . Takes almost 5° misalignment . . . Can be run equally well in either horizontal or vertical installations . . . Operating temperatures may be as high as 150°F . . Wide range of horsepower capacities and shaft speeds to 5000 rpm. And it's priced as low as *half the cost* of comparable all-steel couplings! Ten bore sizes available NOW from stock.

Bulletin N-1 gives the complete story of the new Sier-Bath Nyflex coupling. It's yours for the asking.

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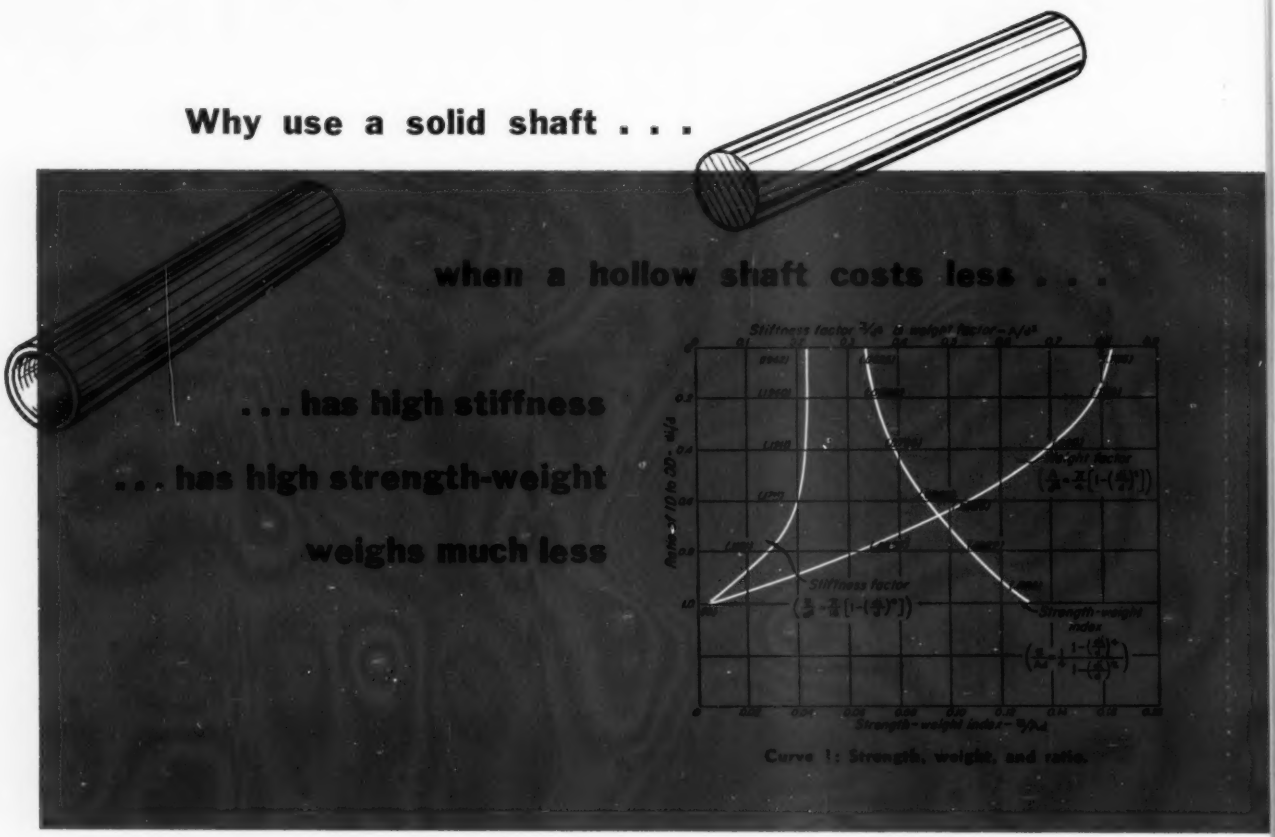

Why use a solid shaft . . .
when a hollow shaft costs less . . .
. . . has high stiffness
. . . has high strength-weight
weighs much less
Stiffness factor
Strength-weight index
Curve 1: Strength, weight, and ratio.

Why not transmit power with

By **DENNIS P. HANLEY**, *instructor, University of Maryland*

HOLLOW SHAFTS CAN BE USED instead of solid shafts within the operating range of most applications. Let's compare the two.

The section modulus of a hollow cylindrical cross-section is

$$Z = \frac{\pi}{16d}(d^4 - d_i^4) \quad \text{.....(1)}$$

which, in non-dimensional form is

$$\frac{Z}{d^3} = \frac{\pi}{16}\left[1 - \left(\frac{d_i}{d}\right)^4\right] \quad \text{.....(2)}$$

Hence, for a required stiffness, as calculated from $Z = \frac{T}{(S_s)}_{max}$, if the diameter ratio is specified, the OD may be found; conversely, if there is a limit because of physical considerations on the OD, the diameter-ratio may be found. Z/d^3 is the stiffness factor.

Similarly, the area is proportional to the weight

$$A = \frac{\pi}{4}(d^2 - d_i^2) \quad \text{.....(3)}$$

Or, in non-dimensional form

$$\frac{A}{d^2} = \frac{\pi}{4}\left[1 - \left(\frac{d_i}{d}\right)^2\right] \quad \text{.....(4)}$$

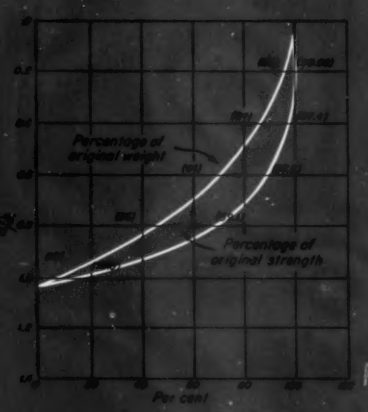
where A/d^2 is referred to as the weight factor.

The ratio of stiffness factor to weight factor is the strength-weight index

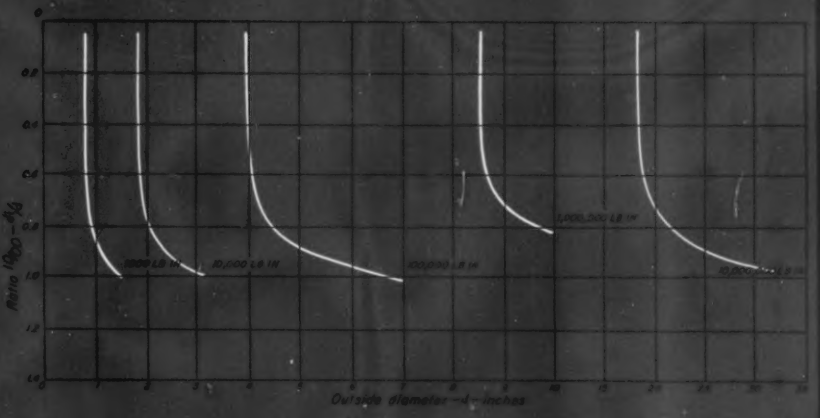
$$\frac{Z}{Ad} = \frac{1}{4}\,\frac{1 - \left(\frac{d_i}{d}\right)^4}{1 - \left(\frac{d_i}{d}\right)^2} \quad \text{.....(5)}$$

This appears to be indeterminate for $d_i = d$ (which is of no practictal consequence). However, it converges toward a finite value from

. . . retains most original strength . . . carries nearly same torque



Curve 2: Percent of original strength-weight.



Curve 3: OD vs d_i/d for different torque

hollow shafts?

the graph as can be shown by applying L'Hospital's method of evaluation. These three properties are shown above (Curve 1).

The significance of these curves shows that any number of combinations of OD with different values of d_i/d may be chosen. The limiting case is usually such that the reduction in torsional rigidity is not excessive. The shaft must not be so thin as to buckle, crimp or suffer extreme deflection under conditions other than pure torsion.

To illustrate the strength-weight advantages of hollow shafting of a fixed outside diameter, there is a very gradual decrease in strength while the weight drops off at a considerably more rapid rate as d_i/d increases. For practical applications, where d_i/d is between 0.4 and 0.8, strength is reduced 3% to 40% and weight decreases between 15% and 65%.

To select a shaft for nearly pure torsion, limit the maximum torsional stress to some value. Reference to the ASME code for the design of shafting indicates a value of 8000 psi for ordinary shafting steels. So, employ the previous relationships to obtain

$$d = \sqrt[3]{\frac{T}{(s_s)_{max}\frac{\pi}{16}\left[1-\left(\frac{d_i}{d}\right)^4\right]}} \quad \text{.....(6)}$$

If the applied loading produces the maximum allowable stress

$$d = \sqrt[3]{\frac{T}{1570\left[1-\left(\frac{d_i}{d}\right)^4\right]}} \quad \text{.....(7)}$$

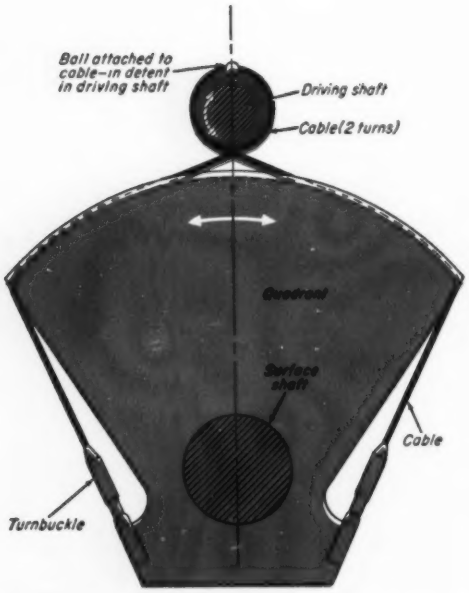
Assuming that the torque is known and that either a certain reduction in strength or weight is desired over that of a solid shaft of the same diameter, select a value of d_i/d from curve 2. From curve 3 read the required OD and conversely the diameter-ratio if a larger d be used. If the maximum shearing stress developed is different from the recommended value of 8000 psi max, the diameter thus chosen from curve 3

Continued on page 53

Spiral damping of a test aircraft is achieved with two external surfaces powered by a single servo motor. The motor has 100 in-lb torque and gains 12-1 advantage with cable-driven quadrants.

Cable drive improves servo

By **DONALD W. RHOADS**, *flight test engineer, Cornell Aeronautical Laboratory, Inc.*



CABLE ON DRIVER SHAFT at top turns larger shaft at bottom through quarter-section quadrant.

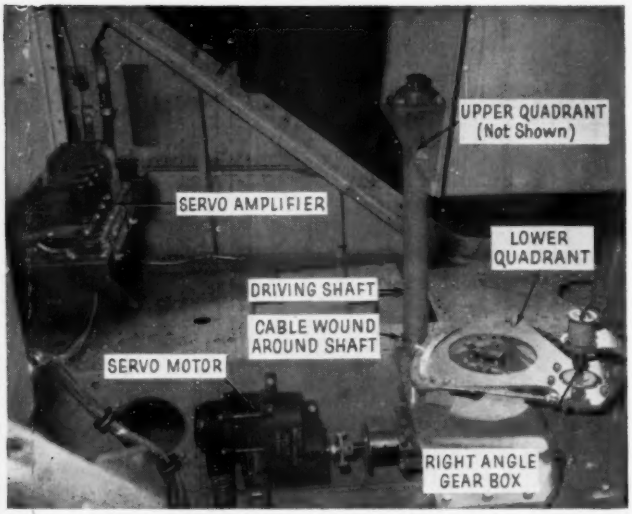
TWO CABLE-DRIVEN QUADRANTS, powered by a single servo motor, power external control surfaces of a test aircraft. The surfaces are used to vary spiral damping under poor simulated conditions of visibility during flight.

Each of the two surfaces has a quadrant; and each quadrant is connected by cable to the same drive shaft. The drive shaft is powered by the servo which is part of a position feedback-type servomechanism.

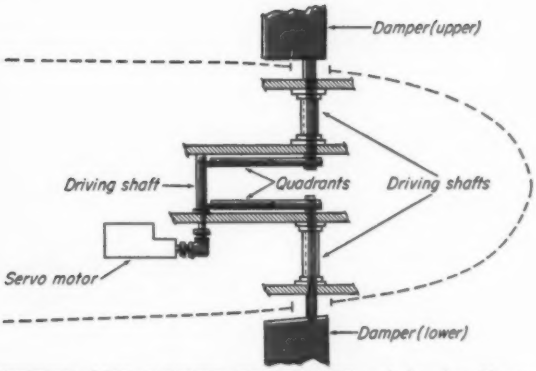
The servo motor has a maximum shaft speed of 24 deg/sec. This, geared down through the quadrants, produces a 12:1 reduction providing two deg/sec surface shaft speed. For the aircraft, this is considerably faster than the 0.7 deg/sec required for spiral response.

The auxiliary surfaces have symmetrical cross-sections so that equal force increments of lift are obtained regardless of angle of attack relative to the wind. The center of pressure is at the quarter chord point and does not vary with angle of attack.

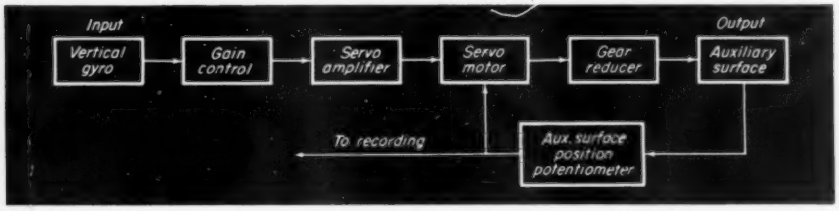
Thus, with the axis of rotation or hinge-line located at the quarter-chord point, all aerodynamic hinge moments (torque) should be eliminated.



SERVO MOTOR provides precise control through right-angle gears and two quadrants.



UPPER AND LOWER SURFACES rotate simultaneously as servo motor powers both with cable.



SIMPLIFIED ELECTRICAL CIRCUIT gives system precise positioning ability.

system efficiency

In actual operation, however, the center of pressure and hinge-line do not necessarily coincide. The resulting moment requires additional power to offset.

The motor has 100 in-lb torque which is more than adequate for this. It is an air-cooled, two-phase, reversible, induction type. Operation is controlled through a 400-cycle external amplifier.

The motor is mounted with the shaft in a horizontal position. Since the surfaces are mounted in a vertical axis, a right-angle gear box is used which is coupled to the single driving shaft. Flexible couplings compensate for misalignment.

Due to space limitations, the two surfaces are mounted on separate shafts. Thus, the two pie-shaped quadrants transmit motion from one driving shaft. The motor, driving shaft, and surface shafts are supported by a framework built in the aircraft nose.

This is a second-order system with inertia, damping and stiffness correction characteristics. Inherent dynamic characteristics are negligible; that is, a constant output-input ratio exists throughout the frequency band-width in which it operates. This means that the equipment is fast enough to respond to the servo motor input with negligible phase lag.

Mathematically, the spiral mode of the aircraft is represented as an exponential function of $e^{\lambda t}$
where

λ is composed of stability derivatives

The symbol λ is varied by the control to produce the required convergent-divergent characteristics. The choice of the derivative to vary in λ includes taking into effect damping and range. A yawing moment proportional to bank angle is used as the variable derivative. The yawing moment is provided by the two driven surfaces.

The bank angle of the airplane is sensed by a vertical gyro. This signal is transmitted to a gain control which determines how much the surfaces will deflect for a given bank-angle input. This deflection determines the magnitude of the derivative artificially added and hence the amount of spiral damping. The gain can be set at the pilot's discretion, thus enabling him to fly as many configurations as practicable during flight.

The control signal is amplifed by the servo amplifier sufficiently to drive the motor. The motor drives the auxiliary surfaces and their position is fed back to the motor closing the loop.

The purpose of this aircraft is to determine, from flight test, the acceptability of various amounts of spiral damping.

The big advantages of Taper-Lock mounting are now available for practically all of your sprocket installations. Below is listed the new wide range of types and sizes offered by Dodge!

This important expansion of the Dodge line is the result of the enormous popularity of the Taper-Lock idea. Taper-Lock Sprockets are *modern*. Industry likes them because they go straight from shelf to shaft without machining—saving time. They are "easy on—easy off"—saving work. Their bushings can be re-used, not only in replacement sprockets, but in sprockets of different sizes and also in Taper-Lock Sheaves, Couplings, Conveyor Pulleys. Taper-Lock saves inventory—and money!

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Transmission Series (No. 2040 to 2080) and Conveyor Series (No. 2040 to 2100). Sprockets to 112 teeth—including, for the first time, stock sprockets of 17, 19, 21, 23, 25 and 35 teeth *made especially for double pitch chain*. Introduced by Dodge, these sprockets are designed for even distribution of tooth engagement and absolute accuracy of mesh. Wear is reduced by half. Life of chain and sprocket is doubled!

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No. 35-2 to 80-2. Sprockets to 112 teeth.

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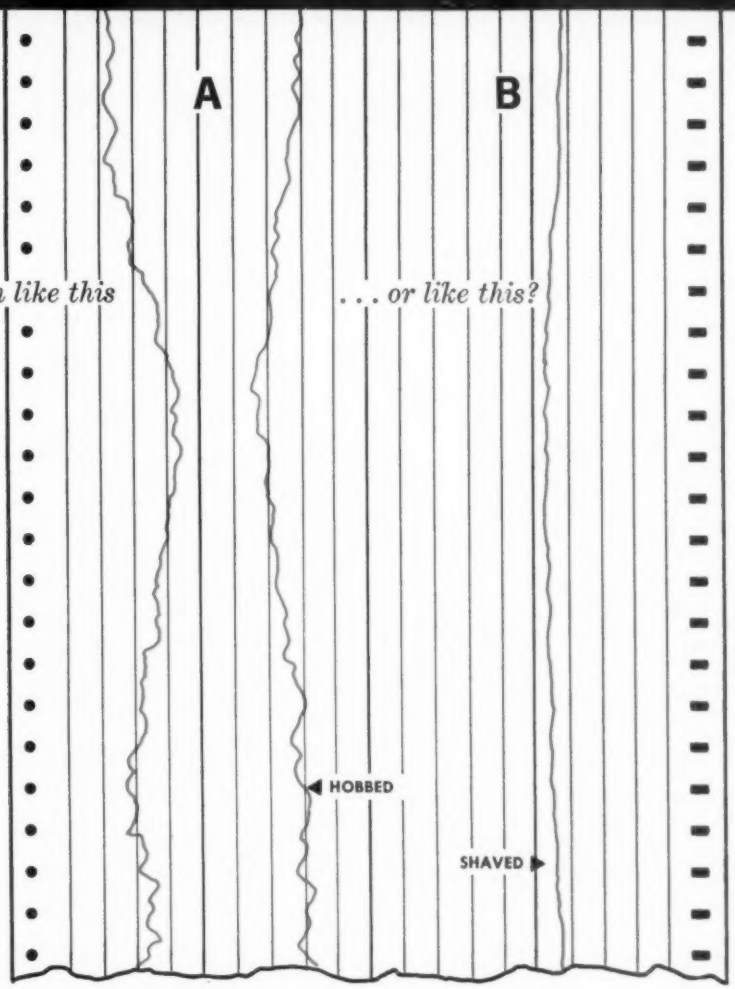


Oscillograph traces show comparison of shaved and hobbed gears when rotated against a master gear . . .

Stop operating noise with shaved gears

BY CARL MOTZ, *assistant chief engineer, National Broach and Machine Co.*

OPERATIONAL NOISE of gear trains can be greatly reduced with shaved gears. Shaved gears have undergone final shaving after final gear-cutting.

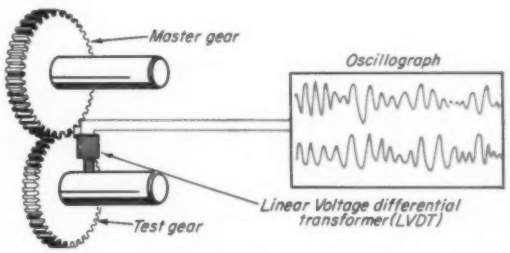
Gear shaving removes only a slight amount of metal from the tooth surface and goes a long way toward eliminating backlash, wear, heat, improper loading and noise. It eliminates basic tooth errors, such as size error, profile error, lead error, tooth-to-tooth spacing error, and runout.

Gear shaving always follows cutting. It is a low pressure, finishing process. Surface smoothness gained eliminates point of load concentration. Shaving also increases the safety factor, load carrying capacity and service life of gear teeth.

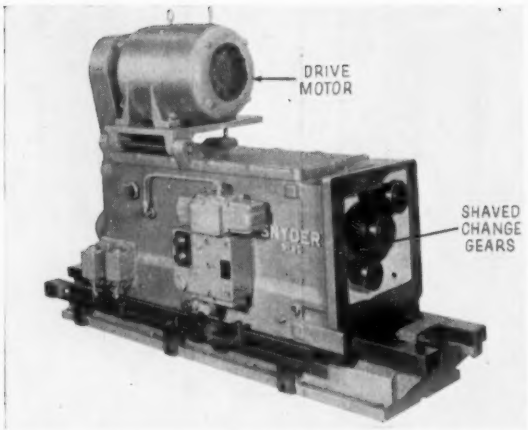
Shaving can be performed with a rotary-type cutter that has the form of a helical gear. When the cutter and gear rotate in close mesh, the cutter shaves a fine hairlike chip from the tooth. The finer the cut, the less the pressure between the two, and the less the tendency of cold working surface metal. Here are the errors that are the major causes of poor performance of gear trains.

Size Error

This exists when teeth are too thick or too thin. The result when too thin is excessive



OSCILLOGRAPHIC TRACE is obtained with linear voltage differential transformer (LVDT) mounted on test gear spindle.



SHAVED HELICAL-REDUCTION gears run quietly and smoothly on machine-tool gearbox.

backlash. The teeth become overloaded on starting or when torque varies during running. When too thick, too-tight meshing occurs. High tooth loading causes wear and creates heat and bearing overloads.

Profile Error

This is when the tooth profiles vary from the theoretically correct involute form. The teeth do not transmit load uniformly from one to the next. This causes concentrated overloads, excessive wear and failure.

Lead Error

This is sometimes called parallelism error. It exists when tooth faces are not parallel. Only a portion of each tooth picks up the load, usually at one corner. Load concentrations result. Lead error can also exist on helical gears along the helix angle.

Tooth-to-tooth Spacing Error

This is a condition in which the teeth are not accurately spaced around the pitch diameter of the gear. Cramping, then open-space action results.

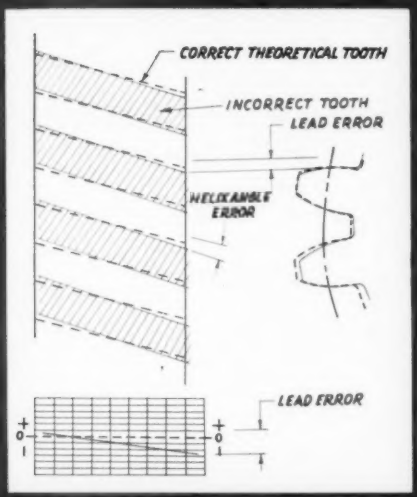
Runout

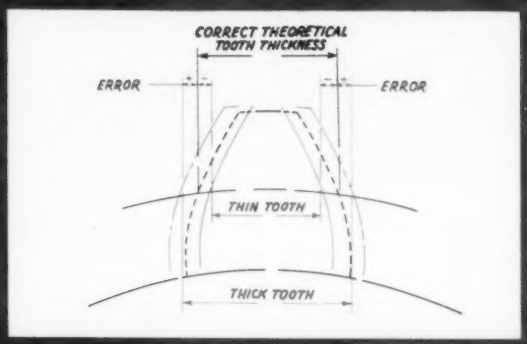
This is sometimes called pitch-line runout. It exists when tooth profiles are eccentric with the true gear center. This causes not only tooth cramping but angular speed variation between the driver and driven gears.

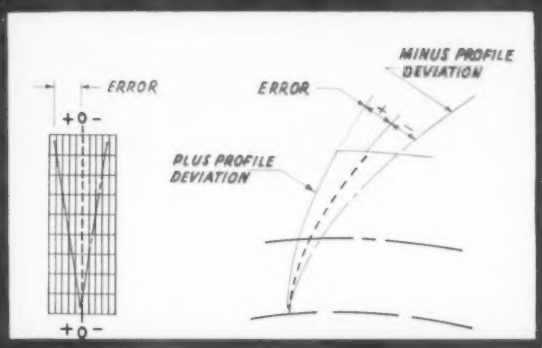
All of these errors, as small and insignificant as they may be, are the chief causes of gear noises, vibration, heat, wear and failure. They add up to a bad dynamic condition of poor operation when more than one of the five is present.

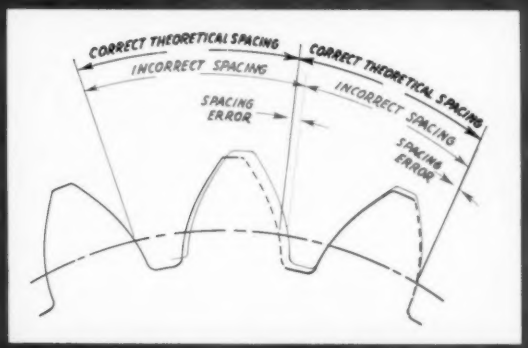
Teeth on many types of gears are machined after heat-treat. They are heat treated to approximately 30-35 Rockwell C before tooth generating. This assures greater accuracy than when gears are heat treated after machining. Sometimes gears heat treated after machining may be harder on the surface but are usually slightly distorted.

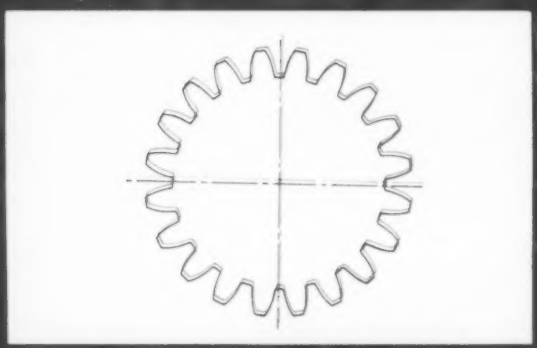
These five gear tooth problems can be eliminated with shaved gears











Shaving takes about 1¼ minutes for a 1-in. wide, 4-in. dia, 10-diametral-pitch gear when stock removal is held to a minimum. The gashed, helical gear-like cutter runs in mesh with the gear; the axis of the cutter is always kept at a small angle to the gear. The cutter drives the gear and feeds it back and forth across the cutter face. The fine hairlike chips are removed from each side of the teeth during shaving.

Typical Tolerances For Shaved Gears

Involute profile	average	0.0003 in.
	maximum	0.0008 in.
Lead	average	0.0004 in-per-in face width
	maximum	0.0008 in-per-in face width
Size	measured over pins	0.001 to 0.002 in.
Eccentricity		0.001 to 0.002 in.
Tooth-to-tooth spacing		0.0005 in.

In some cases it is necessary to crown spur gears to make sure that tooth-end bearing conditions do not occur. Crowned gears have thinner teeth at the ends than at the middle. Shaving does this by rocking the table during the shaving cycle. A maximum crown of 0.0006 inch-per-inch width is recommended for spur gears; half this amount is recommended for each of a pair of helical gears.

When analyzing a gear for tooth accuracy in a tester, the gear is run in mesh with a master. A linear voltage differential transformer (LVDT) is mounted adjacent to the test gear spindle. Its piston rides on the spindle and picks up all irregularities caused by improper gear operation. Signals from the transformer are fed to an oscillograph which traces them as shown on the first page of this article. The trace is an indication of gear size accuracy, roughness, eccentricity and spacing errors. Shaved gears have a smooth trace.

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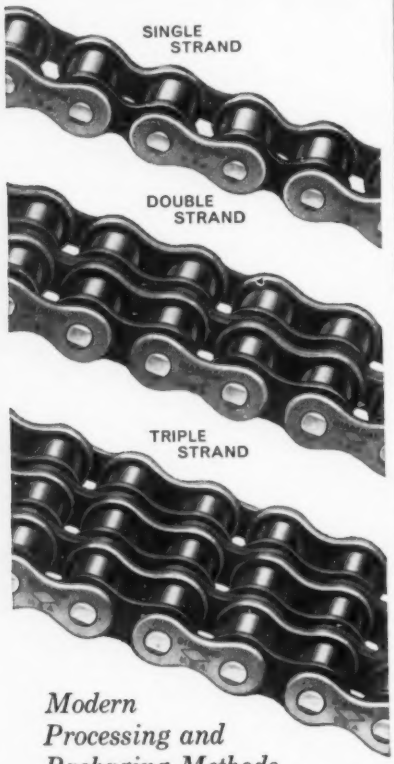

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MEN *continued from page 14*

ter he became the youngest Army officer to receive a battlefield promotion to Brigadier General. He held the rank of Major General when he retired in 1955 after commanding the 82nd Airborne Division at Fort Bragg, North Carolina. He holds the Silver Star, Legion of Merit and the Bronze Star Medal along with several decorations from Allied governments during World War II.

A native of Chicago, General Higgins currently makes his home in Washington, D. C.

H. M. Bowman Joins T. B. Wood's

H. Merrill Bowman, formerly vice-president at The American Pulley Company, Philadelphia, has joined T. B. Wood's Sons Company, Chambersburg, Pa., as vice-president and director of sales. He succeeds Gordon M. Henderson, vice-president, who will assist the president, C. O. Wood, Jr., in the administrative and production operations.

Mr. Bowman was with American Pulley Company for five years. Prior to that, he was with another company in engineering, sales and sales management capacities for nineteen years.

Barden Corp. Appoints Canadian Sales Agent

Philip French Sales, Ltd., Montreal, has been appointed Canadian representative for The Barden Corporation, manufacturer of precision ball bearings.

The Canadian firm is a new organization headed by Philip B. French, president, who was formerly associated with Lyman Tube & Bearing, Ltd., Montreal.

Federal-Mogul-Bower advances executives

Federal-Mogul-Bower Bearings, Inc., Detroit, Mich., has announced some major realignments of responsibilities in the company's management. R. S. Strickland, who has been vice-president—sales and marketing, will head a new grouping of the company's bearing divisions (Bower, Federal-Mogul, and Bearing Co. of America) with the title of vice-president—general manager, Bearing Divisions. R. E. Klare, formerly general manager of the Federal-Mogul Division, has been promoted to a new position of vice-president—operations, Bearing Divisions. R. W. Muzzy, formerly executive assistant to Mr. Klare, has been made general manager of the Bower Division and J. A. McCarthy, general manager of the Bearings Co. of America Division, will continue as general manager of these operations. The sales managers of these divisions, S. E. Davidson for Bower, H. W. Ludwig for Bearings Company of America, and T. J. Marshall for Federal-Mogul, will report directly to Mr. Strickland.

SKF appoints Williams

SKF Industries, Inc., Philadelphia, Pa., announces the appointment of F. Harold Williams as general manager of the newly created Hornell Division. The new division was created and designed to concentrate both manufacturing and marketing responsibilities within a single organization. The Hornell, N. Y., plant will continue its operations under plant manager H. R. Fillmore as an operating unit of the new division.

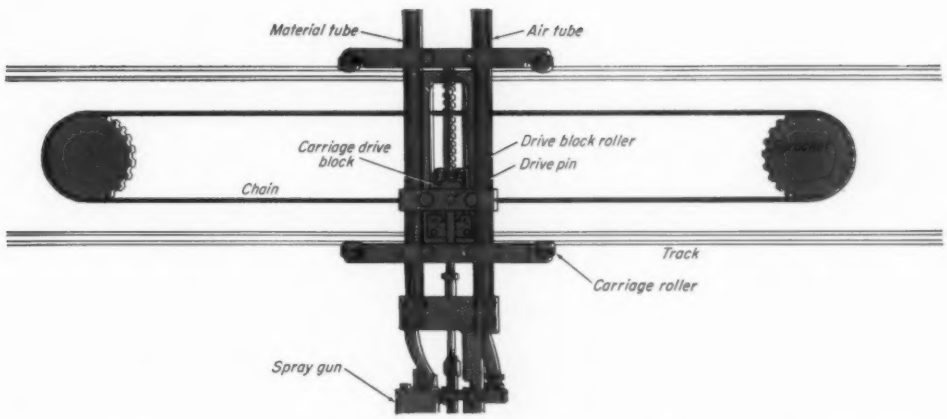
New VP at Square D

Mitchell P. Kartalia, manager of Square D Co., Detroit, Mich., Marketing Division, has been elected a vice-president. Mr. Kartalia is responsible for all programs within the total marketing concept, including distributor relations, field office operations, national advertising, market research, product development liaison, and export activities.

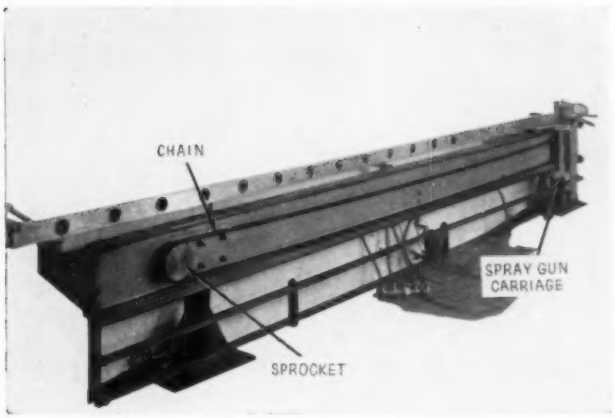
Promotions at Fafnir

Fafnir Bearing Co., New Britain, Conn., has announced

Continued on page 47



Details of the pin and block carriage drive.



Reciprocation of this spray gun carriage is simply done with chain and sprockets.

Chain-sprockets produce reciprocating motion

TWO SPROCKETS and a roller chain move a carriage back and forth in a paint spraying machine. A pin fastened to the chain engages a block on the carriage which causes the reciprocating motion. Slow deceleration and acceleration occur at the ends of the stroke as the pin goes around the sprocket and reverses direction. The block travels vertically on rollers in a guide slot in the carriage.

The carriage is guided and supported by two rails, top and bottom. Rollers on the carriage contact the rails. The carriage carries a spray gun back and forth above pieces being painted. In most cases the pieces are relatively flat and are carried underneath the gun on a conveyor. The gun travels at constant velocity as it passes over the work.

This is a very simple and uncomplicated way to produce reciprocating motion. There is no motion of the drive pin relative to the block and carriage except at the ends of the stroke when the pin is travelling around the sprockets. This means the wear rate is extremely low. The machine is made by Binks Mfg. Co., Chicago, Ill.

7 more pages of ideas

Eliminating involute crown stops heavy tooth-loading

RESHAPING 12 RACK TEETH while retaining the standard 14.5° pressure angle, corrected gear-mesh problems on a cylinder rack. Eliminated was the involute crown which inhibited good rack and pinion movement and smooth pinion-rotation.

Previously, oil was literally squeezed out and cylinder walls were severely abraded. Pinion-teeth scored the rack-tooth surfaces, due to excessive metal-to-metal contact-pressure.

Rack teeth, under pressure, were cut in involute form with little backlash, had tendency to spread apart with no place to go. This scored and bit the rack-teeth; caused high pressure on the seal-ring and scoring of cylinder walls.

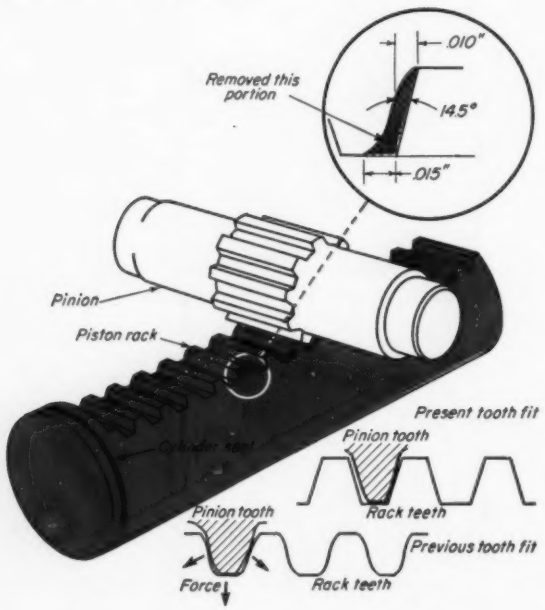
Cylinder oil pressure is 3000 psi, tooth load 6000 psi. Torque at 3000 psi is 14,490 inch-lbs.

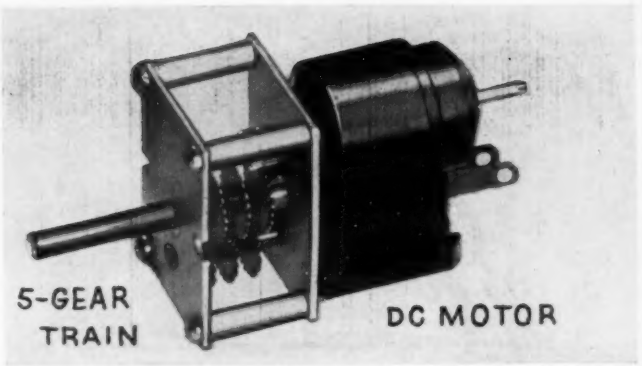
> **Gear data:** 5 D.P.; 14½-inches variable center distance; 2.6 pitch diameter; 2.4 lever arm.

By recutting the rack teeth, removing .010-inch from the top, .015-inch from the bottom, sufficient backlash was allowed. Pinion metal now harder, is Rockwell C-54 to C-56; was C-31 to C-35. It has 100,000 psi yield strength.

These gear and rack improvements were engineered by designers at the National Tool Co., Cleveland, Ohio.

Rack and Pinion meshed properly when rack-teeth were given straight, thinner teeth.





Fractonal hp motor wth gear tran.

Fractional hp motor

FRACTIONAL HP MOTOR powers a completely portable, battery operated, picnic barbecue.

Designed as part of the unit's original equipment, the d-c motor has .09 x 10^{-4} hp, 8000 rpm, 3 volts and 1/3 amp. Its torque rating is .075 inch-oz, rising in locked rotor stall to .35 inch-oz.

It fits into the hollow handle of the sabre-like spit. Its coil has 72 turns of No. 32 wire. Miniature size dimensions are 1-3/8 inches wide, 1-5/8

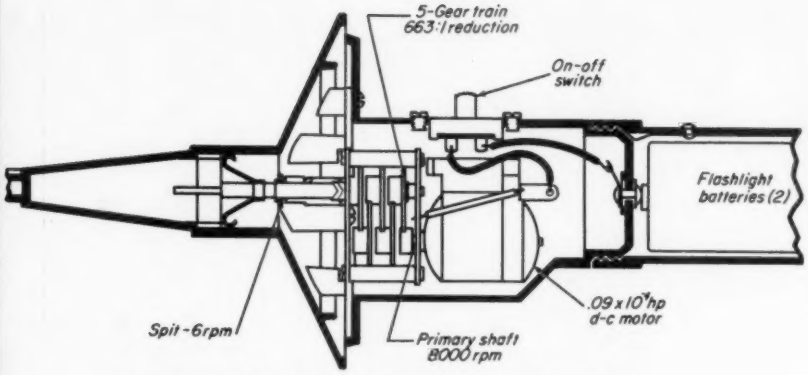
Dry fluid drive solves

FLEXIBLE COUPLING with a dry fluid drive on an overhead crane solved the problem of meeting sanitation and cleanliness standards where food and textiles are handled and stored. An oil drop is undesirable, ruling out the use of oil-fluid drives.

The answer is: Use a dry fluid-driven flexible coupling with steel shot for the fluid action. Clutch used has a five-inch diameter. This is tied in with a herringbone spur gear reducer. Reduction ratio is 25:1. Speed range is from 33 rpm to 355 rpm. The crane using the dry fluid drive travels at speeds ranging from 75 fpm to 400 fpm.

Motor used is the induction type, 3-phase, a-c, 220 volt, 1/4-hp, 1800 rpm. According to future demands to be made on the crane, other voltages available are 440 and 550; horsepower includes those up to 2-hp.

Previously, standard oil-filled single-disc clutches were used. These dripped. Alternative was ballast. A three-coil resistance, in series with the three a-c motor leads. This needed an



Power Transmission from .09x10⁻⁴ hp motor via 5-gear train.

powers portable five-gear train

inches high, and 3/4-inch deep.

Five-gear train transmits power from the 8000 rpm motor, to 6 rpm shaft 3/32-inch in diameter. This 663:1 reduction gives the tiny motor power to turn a six-pound roast over the fire during the 4-hr battery-life.

The problem was to find a power transmission system for a barbecue easily used outdoors. It had to be light enough to hold in the hand, and it had to be able to operate on a pair of ordinary flashlight batteries.

The gears making up the five-gear train have 48 diameter pitch, are made at 14.5° pressure angle. More efficient than a worm gear.

This example of using a fractional motor and gear train to power the barbecue shaft is the idea-development of Russell J. Nadherny Engineers, Chicago, Ill.

a sanitation problem

electrician to adjust it.

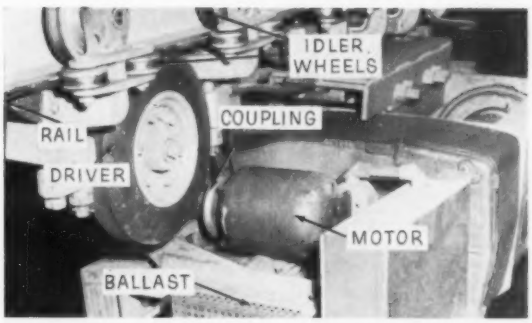
Now, dry fluid drive makes operation of a crane less costly, more efficient. Advantages gained are smooth acceleration control, lack of slip at normal operating speeds, no heat—and no oil-leak drip.

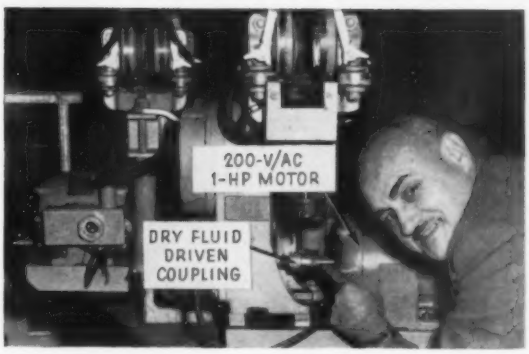
The dry fluid coupling also has the ability to offer protection against equipment-damaging overloads. By varying the flow-charge, the coupling can be made to slip at any pre-determined load.

Main principle is the heat treated steel shot called the flow-charge—contained in the housing. This allows the motor to pick up the load gradually. The hoist does not jerk or snap at its burden.

This is an outstanding example of uses of specific characteristics, so as to arrive at a desired transmission-design-goal. Here, the answer was dry fluid drive.

Idea for this coupling application was developed in the engineering department of the American Monorail Co., Cleveland, Ohio.





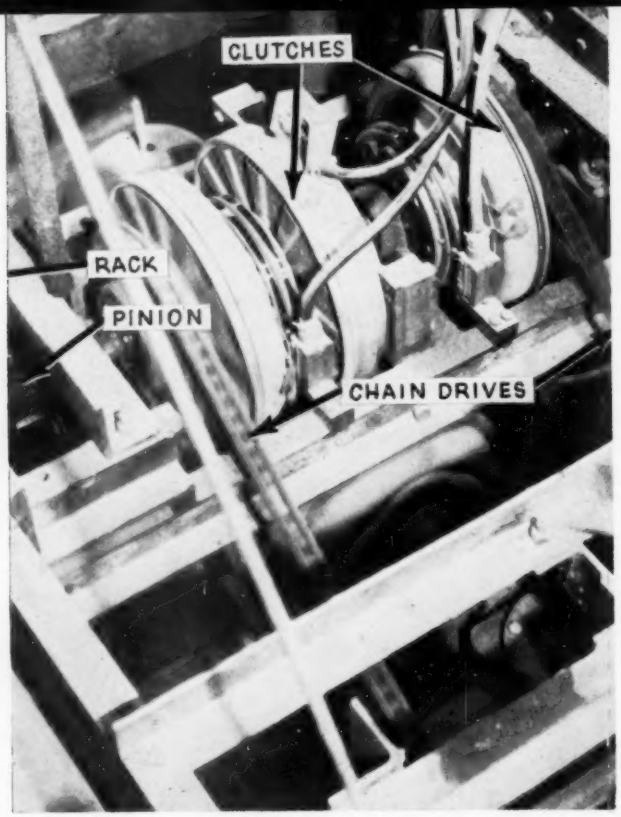
Clutch-brake holds loads during power failure

ELECTRIC CLUTCH BRAKE replaces solenoid-actuated brake on a board-conveyor. The drive is equipped with a reverse switch for up and down travel.

The clutch-brake holds loads during power failure. It is powered by a 3-hp, 1750 rpm, a-c motor. Power is transmitted through miter gear reducer and chain drives to power a rack and pinion which raise and lower the conveyor and its load.

On way up, clutch engages, but releases at top as brake engages. Brake releases for down-travel, engages at bottom before conveyor drops its load.

It is in operation at the Celotex Corp., in Marrero, Louisiana.



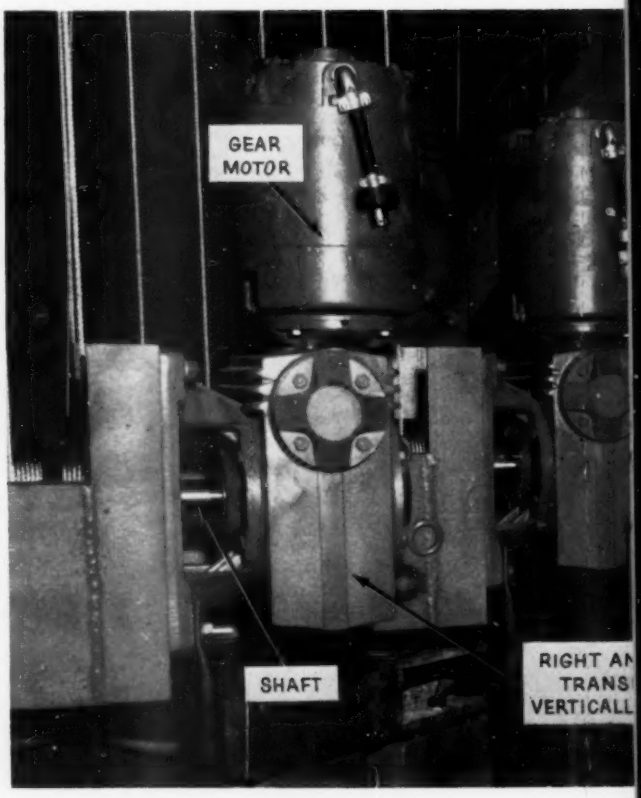
Vertical ratio-motors replace blocks and tackle

TWENTY-FOUR RATIO MOTORS eliminate 40 block and tackle units, using 12-inch pulleys, many feet of heavy rope, and the six men needed to operate them raising curtain and scenery in a theatre.

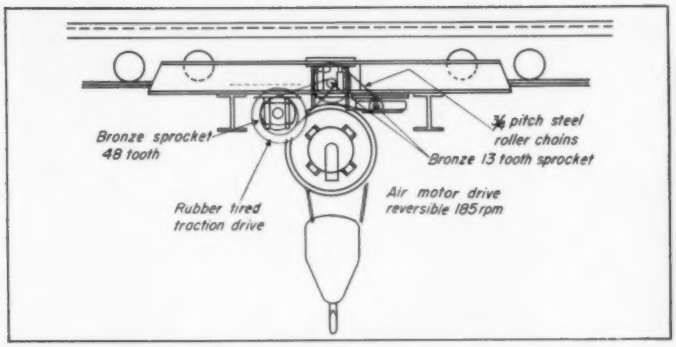
A-c, 60 cycle, 3 phase, 220 volt motors do it 5 times as fast. Each of a 12-unit ratio-motor group now holds six parts of steel cable. Total-line pull is 1679 lbs at 15-fpm. They have 4180 inch-lbs torque, 1-hp, 11.7 rpm, and extended shafts. One of them has an outboard pillow block. Shaft extensions turn six, 5-groove, 8-inch diameter V-belt sheaves that have had grooves removed.

Second group of 11 has 1 ton total line-pull, uses 6 cables, has 17.5 fpm lift speed, 1½-hp, and 7935-inch lbs torque. A single unit lifts the curtain, has 1150 lbs line-pull at 73 fpm.

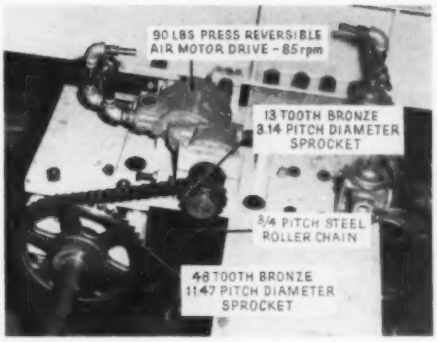
Installation is at the Exhibition Hall of the City of Miami Beach, Florida.



RATIO-MOTORS eliminated block and tackle and now do a faster, more efficient job. Also replaced six men, many feet of rope.

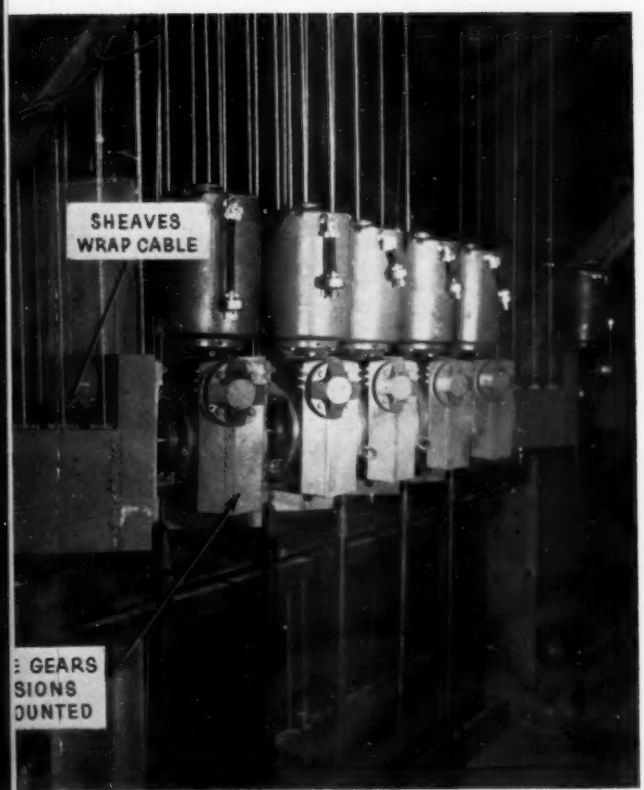

Bronze sprocket 48 tooth
¾ pitch steel roller chains
Bronze 13 tooth sprocket
Rubber tired traction drive
Air motor drive reversible 185rpm

BRONZE SPROCKET and steel chain make crane operation safe.


90 LBS PRESS REVERSIBLE AIR MOTOR DRIVE – 85rpm
13 TOOTH BRONZE 3.14 PITCH DIAMETER SPROCKET
¾ PITCH STEEL ROLLER CHAIN
48 TOOTH BRONZE 11.47 PITCH DIAMETER SPROCKET

CHAIN, sprocket, and air motor.

Bronze sprockets, rubber tire eliminate fire hazard



BRONZE SPROCKETS working against steel roller chains are spark proof, provide fireproof protection for crane operation in a fireworks factory.

The crane-motor is reversible, air-operated to guard against sparks, weighs 31 lbs., 185 rpm, uses 90 lbs air pressure.

Air motor overcomes the wear problem present when soft metal is used. Acceleration and deceleration are eased.

Three sizes of sprockets are used. On the crane: 48-tooth, bronze sprockets with 11.47 pitch diameter. On the air motor: 13-tooth, bronze, with 2.14 pitch diameter. Both are ¾-inch thick. On the carrier: a double set gives double reduction. Here sprockets have 36 teeth and a pitch diameter of 8.61. Chains used are ¾-inch pitch steel roller chains. Crane moves at 75fpm, being driven by two rubber-tired friction drives which move it on its rails.

With the airmotor, the impact of reversal and start-stop is cut down and it helps in overcoming inertia. And, an air-motor gives infinitely variable speed control.

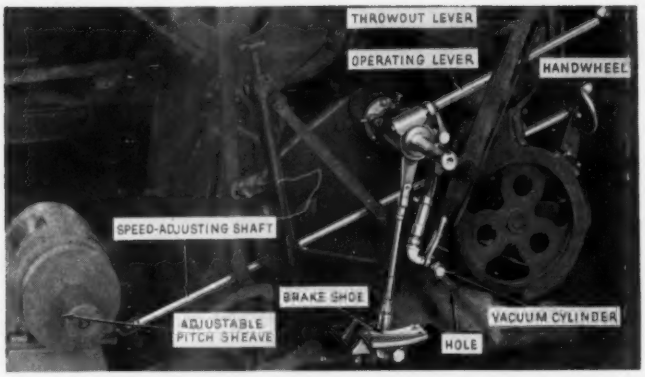
Wheels carrying the crane are also made of bronze and roll on steel rails. End stops are of brass. The double set of sprockets on the carrier uses the same type air motor but the double set of sprockets doubles the reduction, lowering the speed to 60-fpm. Distance traveled: 24-ft.

This is an outstanding example of how specifications of a special problem can be met by using components so as to take advantage of their particular qualities. Meeting needs of fireproof operation and making that operation efficient, less costly, and feasible draws on the engineer's facilities for problem solving.

Choosing non-sparking metals, applying the useful air-powered motor, making the rubber tired drive assist in spark-elimination, are all examples of idea-application.

This is the development of the American Monorail Co., Cleveland, Ohio.

Vacuum cylinder controls clutch-brake on press



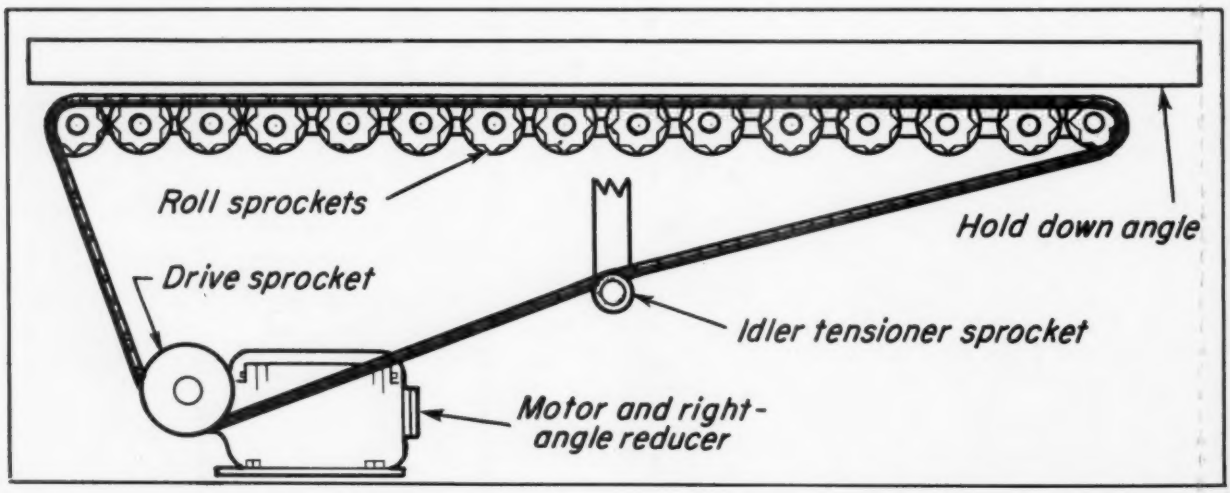
VACUUM - OPERATED CLUTCH - BRAKE setup shown with flywheel and driver sheave removed.

A VACUUM SYSTEM engages a reciprocating bar on a printing press that disengages a clutch and applies a brake when paper supply is exhausted.

During normal operation, vacuum is applied continuously. When the vacuum is broken because a sheet of paper is not picked up by the feed suction cups, the piston is extended by a spring in the cylinder. The end of the piston is forced into a hole in a flat bar attached to an oscillating portion of the press.

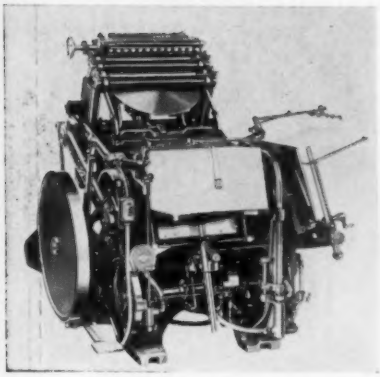
The flat bar then moves the throwout lever until a dog on the lever engages a hook on a sleeve through which the press drive-shaft runs. Further movement of the throwout lever rotates the sleeve to disengage the clutch and apply the brake.

The brake is operated by an arm on the sleeve. Rotation of the sleeve moves the arm which is part of a toggle linkage so an over-center spring arrangement can force the brake

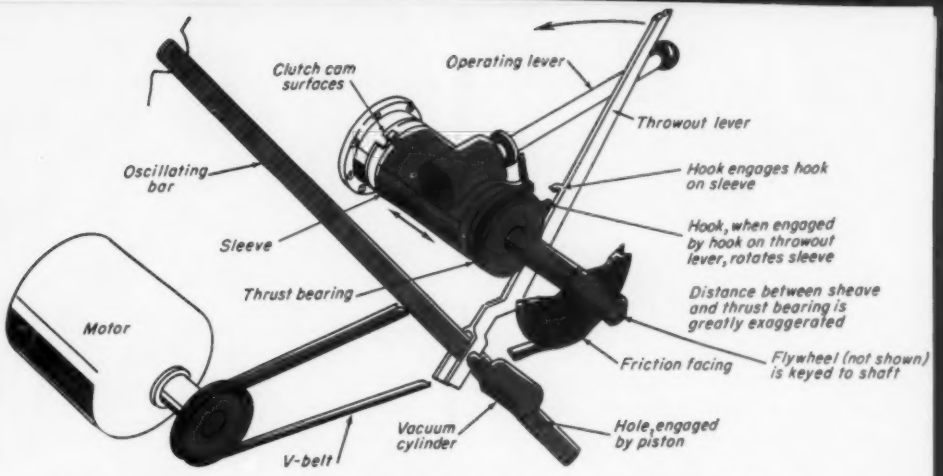


CHAIN AND SPROCKET drive with an angle to hold the chain in mesh with the sprockets over the long flat span, solves the problem.

DRIVE PROBLEM is created by small, closely-spaced rolls on this can-filling machine. Motor and right-angle reducer can be seen here.



PRINTING PRESS stops when no paper is fed.



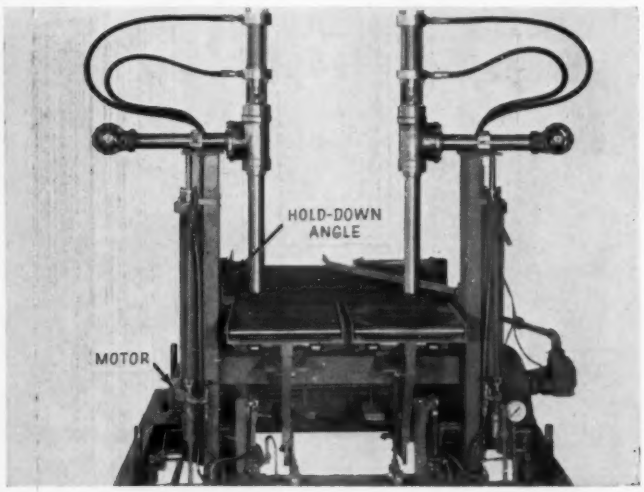
TOP VIEW of automatic vacuum trigged clutch-brake system shows relative locations of clutch, flywheel, driven sheave, and operating sleeve.

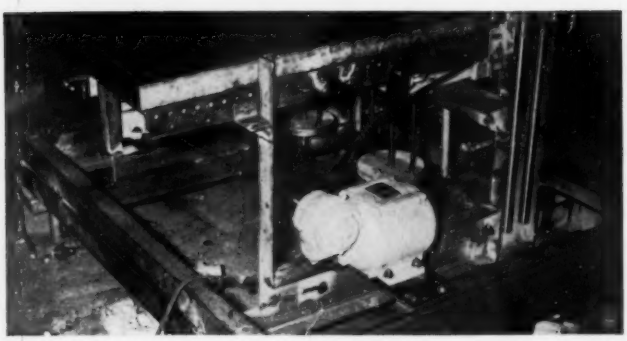
shoe against the bottom of the flywheel.

To let the machine be run for setup, with no paper feeding, the operating lever is used. This lever, attached to the operating sleeve will rotate the sleeve and also, by a collar, hold the hook which engages the dog on the throwout lever so that engagement cannot be made. The press continues to turn under these conditions even though the throwout lever is being moved by the flat bar.

Operating speed of the press is adjustable from 1500 to 4500 impressions per hour by a sliding motor base and an adjustable-speed sheave on the motor shaft. A shaft and universal joint connect the base adjusting screw to a handwheel at the front of the machine.

Manufacturer is The Chandler & Price Co., Cleveland, Ohio.





Guided chain drives close-center rolls

SMALL ROLLS, CLOSELY SPACED are driven by a flat span of roller chain and special sprockets on an automatic can filling machine. The 1-in. diam rolls, spaced 1⅛ in. center to center, convey the cans being filled through the machine. Small size and close spacing keep small cans from tilting as they travel over the rolls.

Because of the long flat span of chain along the tops of the sprockets a hold-down angle is used to keep the chain in mesh with the sprockets. On the bottom of this angle is a wear strip. This is replaceable.

The rest of the drive consists of a right-angle gearmotor and tension adjusting idler sprocket. Drive sprocket is mounted on the gearmotor output shaft. Chain used is ¼-in. pitch. Sprockets on the rollers are special with 12 teeth.

Other methods considered for driving such closely spaced rolls involved quite a bit more complication. For example, one method was using staggered drivers with every other roller driven by gears; another by V-belts. Considerably more equipment was necessary to power all rolls.

This machine is a product of Crandall Can Filler Machine Co., Buffalo, N. Y.

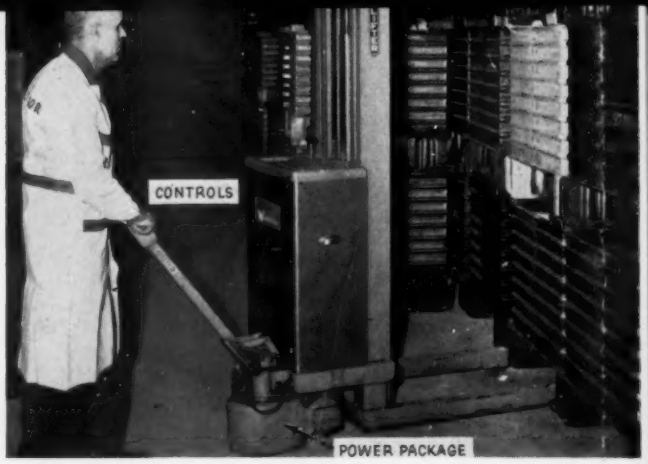
Simple relay circuit gives 2-speed control

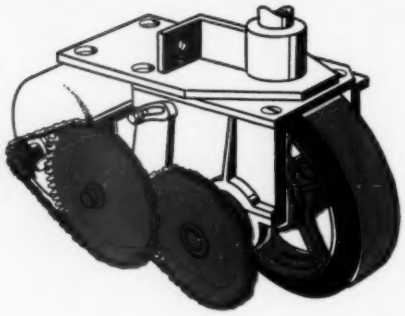
HIGH AND LOW SPEEDS are quickly selected by pushbutton on an operator-guided lift truck. Direction of travel is reversed just as easily by a butterfly switch. Both pushbutton and switch are located on the steering handle.

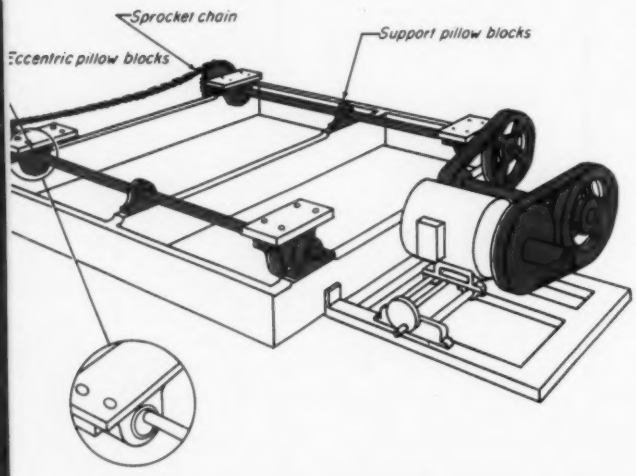
When the 2-speed pushbutton is pressed, it first completes the circuit through contact 1 to energize the field contactor coil which closes the field contacts, and energizes the field. Depressing the pushbutton further completes the circuit through contact 2 of the pushbutton to energize the resistor cutout contactor coil which closes the contacts and shorts out a resistor in series with the motor armature to let the motor operate at high speed, 1725 rpm.

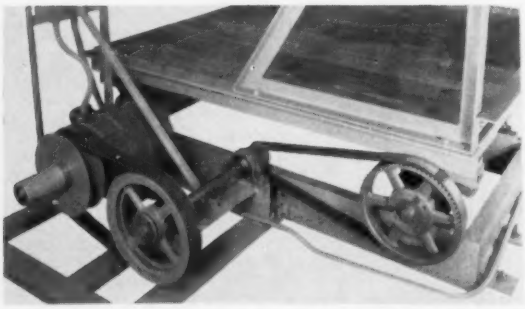
The butterfly switch energizes either forward or reverse contactors to apply power to the motor armature. Direction of current flow determines the direction of motor rotation.

The motor is built into a compact drive package that includes a double chain and sprocket reduction, and the drive wheel. The whole package is mounted on a pivot and is swiveled for steering. Economy Engineering Co., Chicago, Ill., makes the truck.









STANDARD POWER TRANSMISSION COMPONENTS are the heart of this vibrating machine.

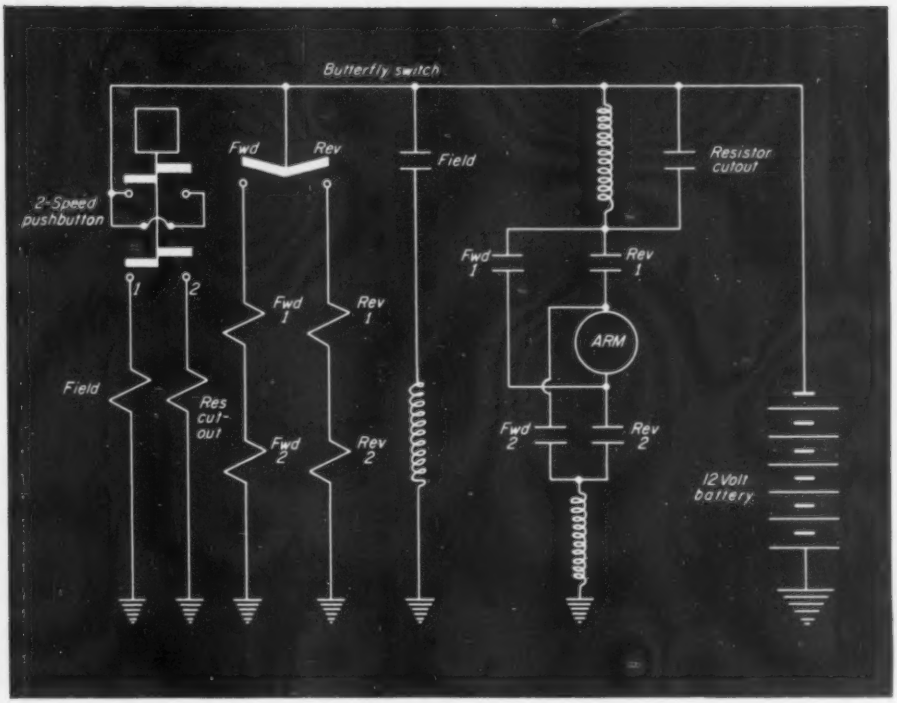
Eccentric pillow blocks give vibratory motion

PILLOW BLOCKS, VARIABLE-SPEED SHEAVE, TIMING BELT, CHAIN AND SPROCKETS are standard power-transmission components used in a vibrating test platform. The machine is used to test shipping cartons at loads of 0.5 to 1.25 g.

A standard, 1740-rpm, squirrel-cage motor on a sliding base drives an adjustable-pitch sheave. The sheave connects to a countershaft by a wide-range V-belt and sheave. A timing belt connects the countershaft to one of the eccentric shafts which vibrates the table. The other eccentric shaft is driven by chain and sprockets, on the other side of the table, from the belt-driven shaft.

Each eccentric shaft is supported by three standard pillow blocks mounted on the machine base. Two eccentrics on each shaft revolve in pillow blocks mounted to the bottom of the vibrating table. The pillow blocks at the front of the table connect to the table through sliding dovetail joints. This lets the front of the table be vibrated out of phase with the rear for certain types of tests.

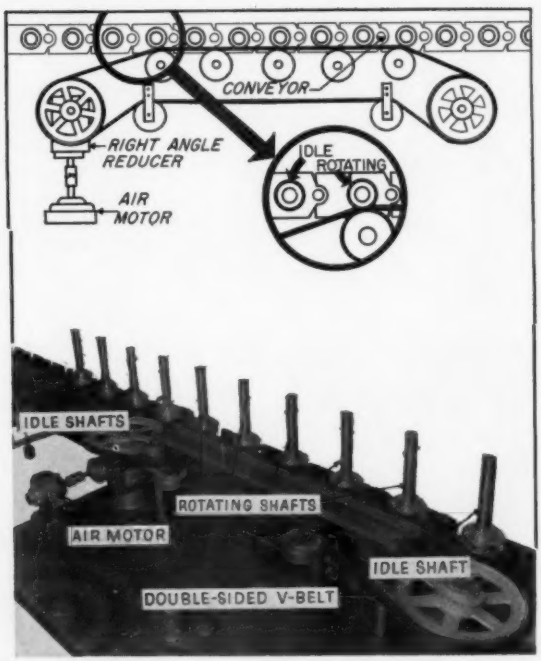
A tachometer connected to the rear shaft is calibrated in g's to show the operator the effective loading at all times. Gaynes Engineering Co., Chicago, Ill., makes the tester.



ELECTRICAL CONTROL CIRCUIT for the two-speed lift-truck drive.

MOTOR CONTROLS are at the operator's fingertips when guiding the lift truck.

COMPACT DRIVE PACKAGE includes motor and double chain and sprocket reduction.



DOUBLE-SIDED V-BELT drives spindles only at the paint-spraying station.

Double-sided V-belt for part-time rotation

A DOUBLE-SIDED V-BELT DRIVE rotates spindles only during actual spraying in a paint-spraying machine. Because paint is sprayed from one side only, the pieces are revolved to get all sides covered.

The pieces travel on the spindles without turning for quite a distance while being prepared for spraying, and again while drying afterward. Each spindle has a sheave which contacts the double-sided belt at the spraying station. The drive system is located at the spray station and the sheaves engage the double-sided belt at this location.

The drive system consists of an air motor, right-angle reducer, two main sheaves, and idler and tensioning sheaves. All units are mounted on a platform next to the conveyor. The air motor is used here because it gives easy adjustment over a wide speed range and eliminates explosion hazards. Air for motor operation is ideal since it is also used in the spray units. Binks Mfg. Co., Chicago, Ill., designed this drive.

Motor minus stator runs in cyclotron's magnetic field

A ROTOR BECOMES A 2/5-HP MOTOR within the magnetic field of a 60-inch cyclotron.

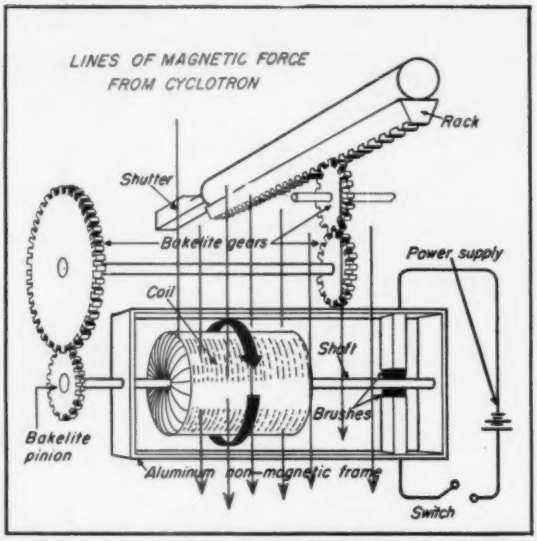
The motor created under these conditions has a 30-inch pound torque, 90 rpm, at 110 volts. Normal motors will not work in the cyclotron because ther magnets become saturated in the unit's magnetic field. Their normal background of 5000 kilogauss is useless.

Solution to the problem is: Use the magnetic field of the cyclotron itself. Needed is: New method of developing torque. The coil, wound on the bakelite rotor, is powered from a 110 volt, d-c power supply. Current passing through the windings sets up a rotor-magnetic field which reacts with the cyclotron's magnetic field, creating torque.

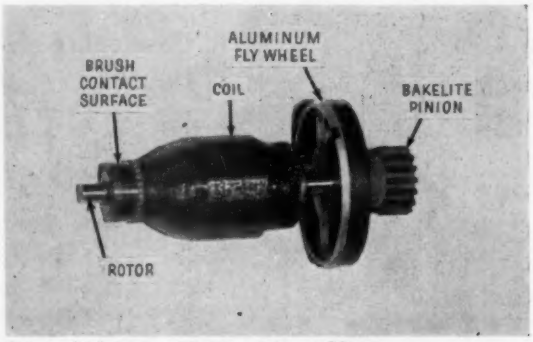
The non-magnetic, bakelite gear train transmits power from the rotor to a positive ion shutter. Eddy currents induced in metallic gears would widen system-power-loss. The rotor is held in a simply constructed, non-magnetic aluminum frame and has bronze bearings and brackets.

Steel and iron parts won't work. Iron is drawn physically to the side of the cyclotron. The motor itself would abrade the bearings. It could not be held in place.

Only alternative: Use massive heavy, costly magnetic shielding.



Motor functions as invisible magnetic field produces torque, turning coil-wound rotor.



Rotor which turns without a stator at 90 rpm.

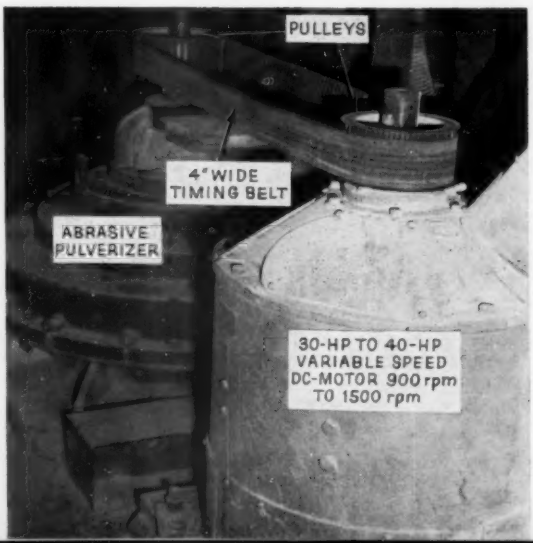
The motor-gear arrangement powers a rack and pinion which operate the shutter that controls and steers heavy ions in an accelerator, at the Argonne National Laboratory, Lemont, Ill.

Timing belt solves slippage problem

TIMING BELT AND PULLEYS solved slippage and abrasive-wear problems on a pulverizer. Two four-inch-wide pulleys, one with 32 teeth, other with 40 teeth, are powered from a variable speed, d-c motor. Motor ranges from 30-hp 900-rpm to 40-hp 1500-rpm.

Previously used were two 12-inch diameter, 7-groove sheaves; and 7 V-belts. Abrasive grains adhered to belts. Slippage abraded sheave-grooves, sidewalls wore in irregular shapes. Self-tensioning V-belts functioned badly in the vertical drive.

This timing belt application is working at the Carborundum Co., Niagara Falls, New York.



Timing belt powers pulverizer crushing abrasives, cuts maintenance costs and length of downtime.

MEETINGS

MARCH 9-12

American Society of Mechanical Engineers, aviation conference, Statler-Hilton Hotel, Los Angeles, Calif.

MARCH 16-20

American Society for Metals, Western Metal Show, Pan-Pacific Auditorium, Los Angeles, Calif. Contact: American Society for Metals, 7301 Euclid Ave., Cleveland 3, Ohio.

MARCH 19-20

Society of Automotive Engineers, national production meeting, Sheraton-Cadillac Hotel, Detroit, Mich., Contact: Robert W. Crary, Public Relations Mfg., SAE, 485 Lexington Ave., New York 17, N. Y.

MARCH 31-APRIL 2

21st American Power Conference, sponsored by Illinois Institute of Technology in co-operation with 9 technical societies and 13 other educational institutions, Sherman Hotel, Chicago, Ill. Contact: R. A. Budenholzer, Mechanical Engineering Dept., Illinois Institute of Technology, 3300 Federal St., Chicago 16, Ill.

MARCH 31-APRIL 3

Society of Automotive Engineers, national aeronautic meeting, aeronautic forum, and aircraft engineering display, New York, N. Y. Contact: Robert W. Crary, Public Relations Mgr., SAE, 485 Lexington Ave., New York 17, N. Y.

APRIL 5-10

Instrument Society of America, nuclear congress, Cleveland, Ohio. Contact: Dr. S. Baron, 160 West Broadway, New York, N. Y.

APRIL 14-15

Society of Automotive Engineers, Central Illinois Section, Tenth Annual Earthmoving Industry Conference, Peoria, Ill.

MAY 25-28

American Society of Mechanical Engineers, Machine Design Div., design engineering conference and show, Convention Hall, Philadelphia, Pa. Contact: Clapp & Poliak Inc., 341 Madison Ave., New York 17, N. Y.

MEN *continued*

changes in several top executive positions. Charles F. Stanley, vice-president of Fafnir Bearing Co., New Britain, Conn., retired December 31, ending a forty-year sales career with the company. Mr. Stanley joined Fafnir in 1915, and in 1940 was elected to the board of directors. During 1952 Mr. Stanley served as director of the General Components Division of the National Production Authority in Washington. Mr. Stanley will continue to serve Fafnir as a director. Keith T. Middleton and Richard F. Cooper were elected administrative vice-presidents. Mr. Middleton will retain the office of secretary. Both will assist president Clarence G. Rosensweig in administration of the company. Other changes were as follows: general sales manager Robert W. Powell was elected vice-president—sales; he succeeds Mr. Stanley. General works manager Franklin S. Atwater was made vice-president—manufacturing, succeeding Mr. Cooper; and assistant treasurer Randolph B. Robert was elected treasurer, succeeding Mr. Middleton in this office.

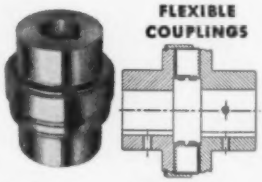
Bunting Brass makes new sales-area heads

The Bunting Brass and Bronze Co., Toledo, Ohio, has announced the following appointments: Robert E. Hawkins represents the firm in the southwestern area, handling sales engineering operations in Texas, Oklahoma, Louisiana, Mississippi, and Arkansas, with headquarters in Dallas, Tex.; George S. Mountford of Westlake, Ohio, services northern Ohio, western Pennsylvania, and West Virginia, operating from Westlake; Joseph T. Weber joins the Chicago district sales office, serving accounts throughout Wisconsin and Minnesota, with headquarters in Milwaukee; James N. Guthrie is assisting James R. Schultz, senior sales engineer, in the Philadelphia office.

continued on page 71

Lovejoy

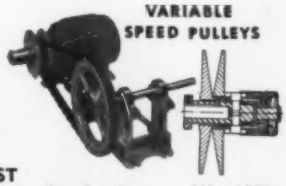
POWER TRANSMISSION EQUIPMENT EASILY INSTALLED, MAINTENANCE-FREE



FLEXIBLE COUPLINGS

REQUEST CATALOG C-58

Bores (max.) ...5/16" to 9½"
O.D. .....⅝" to 21½"
Wt. .....½ oz. to 1500 lb.
H.P. .....1/20 to 4250



VARIABLE SPEED PULLEYS

REQUEST CATALOG P-58

Bores (max.).....½" to 1⅜"
O.D. .....3" to 13⅜"
Belt Sizes.....A to 2¾ TW
Speed Ratios.....1-1 to 8-1
H.P. (1750 rpm.).....¼ to 15

UNIVERSAL JOINTS

REQUEST BULLETIN 820

Bores.....¼" to 2"
Hub Dia. .....½" to 4"
Static Torque 340 to 130700 in.-lbs.
H.P. (100 rpm.).....½ to 207

SHAFT MOUNTED GEAR REDUCERS

REQUEST CATALOG R-58

18 Models From Stock
Speeds.....8 to 425 R.P.M.
H.P. .....Fractional to 120
Ratios.....Single 4.5:1 Nominal
Double 14.7:1 Nominal
Hollow Shafts.....1⅜ to 3⅞ in.

LOVEJOY FLEXIBLE COUPLING CO.

4852 West Lake Street, Chicago 44, Ill.

Circle No. 40 on Reader Service Card

NOW

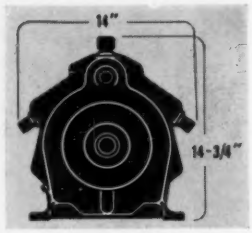
more versatility
for your power team

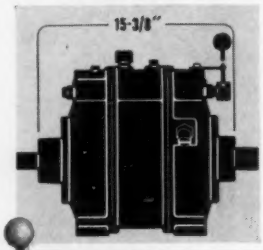
NEW

S-N MODEL 5231

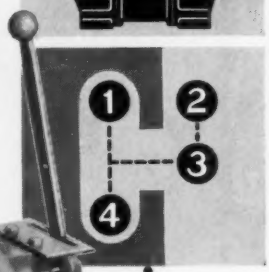
5 in 1

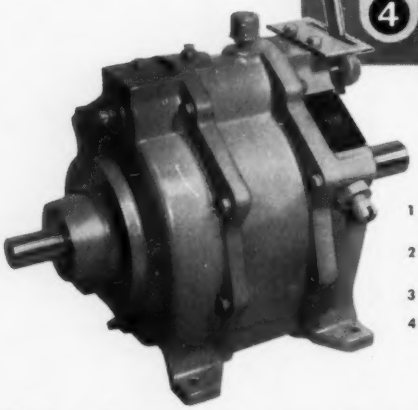
REVERSING TRANSMISSION





Combines 2 speeds forward, neutral, reverse, and reduction into a single compact unit that reverses under full load.





1 FORWARD 3.34 Reduction
2 FORWARD 1.97 Reduction
3 NEUTRAL
4 REVERSE 3.37 Reduction

Here is really good news to power transmission engineers. This new brother to the widely used S-N Reversing Transmissions adds a second forward speed for greater versatility and added power transmission efficiency. New Model 5231 offers limitless possibilities in the design or redesign of agricultural, material handling, machine tool and construction equipment. Write now for full information and literature to The Snow-Nabstedt Gear Corporation, Hamden, Conn.

SPECIFICATIONS MODEL 5231

- Reduction Ratio—1.97:1 and 3.34:1 Forward; 3.37:1 Reverse
- Power Transmission—up to 28 HP
- Maximum input torque—1000 pound inches
- Maximum input speed—2000 RPM
- Dimensions—15 1/16" long, 14" wide, 14 3/4" high
- Includes built-in clutches for reversing under load

SNOW-NABSTEDT

Transmission Engineers
FOR OVER HALF A CENTURY

Circle No. 60 on Reader Service Card

NEW PRODUCTS

Vertical motors work equally

VERTICAL hollow-shaft climatized motors in ratings from 1-hp to 30-hp, provide service, out doors and unprotected, as well as the usual indoor service.

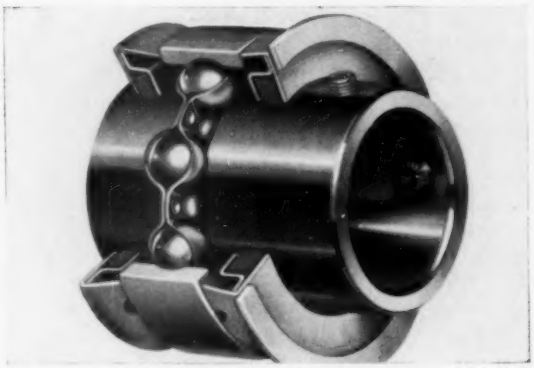
Motor-construction makes it possible to perform in-the-field assembly or remove the coupling and thrust bearings in five minutes, using only a wrench.

Features are: sealed bearing chambers, magnetic drain plugs to collect foreign matter, and an oil-metering system. Entrance of snow and rain is prevented by 90° turns in the air-flow system.

The Louis-Allis Co., Milwaukee, Wisc.

Circle No. 98 on the Reader Service Card

Unit bearings for light



Miniature speed changer

MINIATURE adjustable-ratio speed changer, series 2, has an all-aluminum, black anodized housing with a longer scale that is easy to read.

Supplied with either servo or foot mounts, the unit can be integrally combined with angle-drives. Foot-mounts can be rotated 90° either way. Housing length is 2-5/8 inches. Stainless steel shafts 3/16-inch in diameter run in shielded ball bearings. Ratings are: max hp, 0.025; 10,000 rpm; speed adjustability, 25:1 overall range; torque output, 5 inch-oz to 40 inch-oz, depending on ratio-setting.

Metron Instrument Co., Denver Col.

Circle No. 97 on the Reader Service Card

well indoors and out

loads, normal speeds

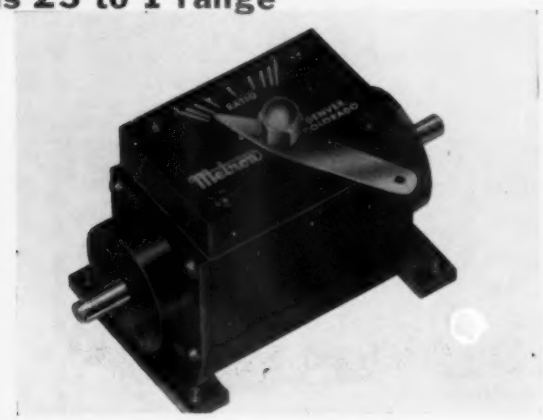
MACHINE unit bearings designed for light loads at normal speeds, include a single-row bearing of deep-groove design with an extended inner ring that is equipped with two set-screws. These lock the bearing on its shaft.

Separable seals may be used, either singly or on both sides of the bearing. A wire lock-ring holds the entire unit securely in its straight-bore housing. Bearings are available in shaft sizes from 1/2-inch to 1-3/16 inches.

Hoover Ball and Bearing Co., Ann Arbor, Mich.

Circle No. 99 on the Reader Service Card

has 25 to 1 range



Circle No. 28 on Reader Service Card

HORTON

VARIABLE SPEED CLUTCH PULLEYS

for
•
soft starts
•
easy acceleration
•
inching drives

Use a Horton Variable Speed Clutch Pulley with an A. C. electric motor and get the same performance as a variable speed drive at a FRACTION OF THE COST.

write for bulletin M-1

HORTON Manufacturing Co., Inc.
Minneapolis 14, Minnesota

NEW from **SEALMASTER**®

QUALITY
PERFORMANCE
ECONOMY

The "LP" Pillow Block

- Precision self-aligning one-piece unit. No extra assembly costs for you.
- Malleable housing provides maximum strength with light weight.
- Permanently sealed—pre-lubricated with high grade lubricant.
- Nothing of comparable value in low price field.

WRITE FOR BULLETIN 1058

BEARING DIVISION
STEPHENS-ADAMSON MFG. CO.
71 RIDGEWAY AVENUE
AURORA, ILLINOIS

"L" & "SL" BEARINGS

"L" BEARING
"SL" BEARING

SEALMASTER
BALL BEARING UNITS

Circle No. 57 on Reader Service Card

COMPLETE LINE OF
ACME ROLLER CHAINS
and ACCESSORIES
Available at YOUR LOCAL
INDUSTRIAL DISTRIBUTOR

Acme Chains are available nationally through reliable Authorized Distributors.

It is the basic policy of Acme Chain to sell its product through *Authorized* Distributors who have entered an agreement with the company to stock merchandise and service all Acme Products.

The quality of all Acme Products will continue to be — as it has been since the founding of the company — the highest quality that experience, materials, design, craftsmanship and facilities can produce.

Acme supports their Distributors with all the knowledge and assistance of their Engineering Department in an advisory and technical capacity.

Order Acme Chain from your Industrial Distributor with implicit confidence that you will receive prompt and efficient service at all times.

Write Dept. 28-B for new 100-page illustrated catalog, including new engineering section showing 36 methods of chain adjustments.

Call **ACME** for Service

Acme Chain Corporation
HOLYOKE
MASSACHUSETTS

COMPLETE LINE OF ROLLER CHAINS AND SPROCKETS • DOUBLE PITCH CONVEYOR CHAINS • STAINLESS STEEL CHAINS • CABLE CHAINS • FLEXIBLE COUPLINGS • STANDARD AND SPECIAL ATTACHMENTS

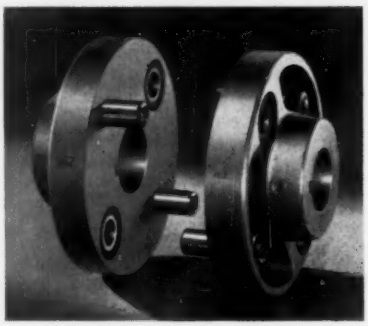
For more information circle No. 3 on the Reader Service Card

NEW PRODUCTS *continued*

Flexible couplings

Four studs and sleeve bearings give positive, resilient drive. No lubrication is needed. Cast, semi-steel flanges are machined on the periphery and face to simplify checking the alignment with a feeler gage or a straight edge.

Couplings come in four sizes with 1¼ inch, 1¾ inch, 2¼ inch, and 2¾ inch maximum bore, respectively, with standard square



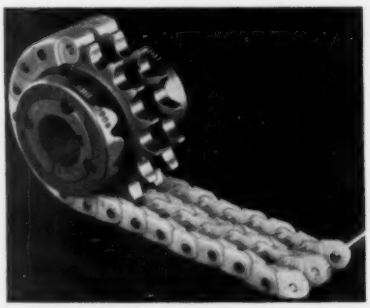
keys. New line is for use on direct-driven machinery where torque is not excessive in relation to shaft-diameter.

The Ajax Flexible Coupling Co., Inc., New York.

Circle No. 201 on Reader Service Card

Nylon coupling

Lubrication-free nylon coupling, completely corrosion-resistant,



has chain element constructed of nylon segments. It can be disassembled or connected at any link without special tools, and fits standard stock steel roller chain sprockets.

It needs no protective cover, handles loads from fractional horsepower to 40-hp, and speed from 500 rpm to 5000 rpm. Complete couplings, ½-inch pitch links and soft steel sprockets, or

chain elements are available.

Morse Chain Co., Ithaca, New York.

Circle No. 203 on Reader Service Card

Servo motors

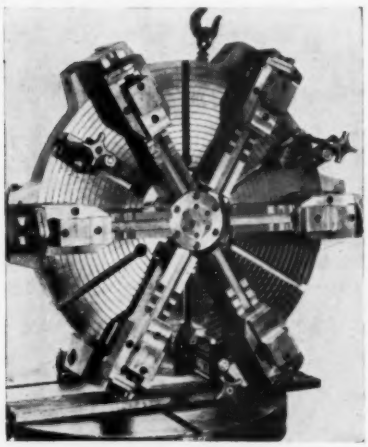
Servo motors, sizes 10 and 11 are now available for 26, 55, or 115 volt, a-c, 400 cycle operation. Special voltage requirements are available on order. These are 6-pole units, having a stall torque of .6-oz-inches minimum, and a no-load speed of 6500 rpm with rotor inertia 1gm cm^2. Acceleration at stall is 42.000 radians/sec^2. They are designed to operate in ambient temperatures from −65°C to +125°C. They measure 1 11/32 in length.

Western Gear Corp., Electro Products Div., Pasadena, California.

Circle No. 202 on Reader Service Card

Universal Chuck

Able to accomodate gears,



chucks are custom built. Rapid-acting jaws pull the workpiece back into the chuck against positive rest stops. Because chucking pressure can be controlled, parts may be chucked without distortion. Parts distorted in heat treat can be re-shaped by increasing the chucking pressure. Available in complete range of sizes.

Thus the potential user is able to select the chuck best suited to his specifications. Since sizes cover a wide range, choosing chucks is facilitated.

Garrison Machine Works, Inc., Dayton, Ohio.

Circle No. 204 on Reader Service Card

For more information circle No. 2 on the Reader Service Card

Abart CUSTOM-CUT GEARS

- exact tolerances . . .
- finest workmanship . . .
- extra-fast delivery

Skilled Abart machinists plus up-to-date methods and equipment insure a perfect gear every time. Abart carries no stocks. Every gear is custom-cut—precision-cut—exactly to your specifications.

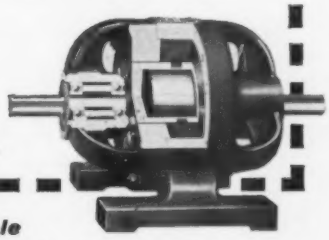
Any type—spur, bevel, worm, worm wheel, helical, spiral, internal, rack, sprocket—any quantity, any gear material. 96 pitch to 5/7 D.P.—from 1/4" to 18" P.D. Send B/P and specs or sample for quotation.

Write for Abart Gear Bulletin.

ABART GEAR & MACHINE CO.

4833 West 16th Street • Chicago 50, Illinois

VICKERS® MAGNECLUTCH™



The most versatile and dependable clutch for power transmission and torque control . . . MAGNECLUTCHES lick the toughest application problems

The Vickers MAGNECLUTCH consists fundamentally of two rotating concentric cylinders coupled by dry magnetic particles under the influence of a magnetic field. With no direct contact between clutching surfaces, there is no wear; life of the MAGNECLUTCH is exceedingly long. Torque is easily regulated by varying the magnetizing coil current.

Unlike all other industrial clutches, torque transmitted is independent of speed. Since starting and running torques are the same, there is no grab or chatter during acceleration or braking periods; operation is extremely smooth. Torque is transmitted at zero slip with 100% mechanical efficiency. MAGNECLUTCHES have a broad range of operating speeds, provide torque limiting, fast response, and can be easily and remotely controlled.

The many unique features of MAGNECLUTCHES make them the most versatile and dependable clutches available, whether for tension control, cycling (start-stop) operation, torque limiting, controlled acceleration, wind-up, starting of high inertial loads, or constant torque transmission. *Write for Bulletin 6000A*

Sales Engineering Offices: Boston • Chicago • Cleveland Detroit • New York • Washington, D. C. • Los Angeles

VICKERS INCORPORATED EPA 6100-1

DIVISION OF SPERRY RAND CORPORATION

ELECTRIC PRODUCTS DIVISION

1817 LOCUST STREET • SAINT LOUIS 3, MISSOURI

For more information circle No. 70 on the Reader Service Card

Don't overlook the power of the worm!

H&S

WORM-GEAR SETS insure smooth driving action between perfectly mated members

Check these important advantages for your power transmission needs:

Smoothness of Operation • Ability to Carry Heavy Shock Loads
Compactness • Large Ratios • Reliability
Long Service Life • Self-Locking

Horsburgh and Scott worm-gear generating methods guarantee perfect mates in each set, with worm threads and gear teeth having identical pressure angles and tooth contours. Resultant smooth conjugate action delivers maximum right angle power transmission with minimum power loss. H&S gives each set a controlled inspection on the correct center distance for tooth contact, backlash and smoothness.

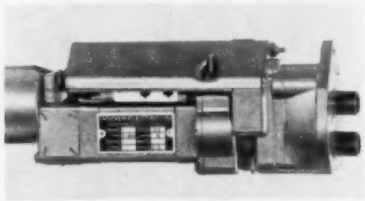
To meet your requirements H&S makes Worm Gears up to 60 inches diameter—circular pitch range from ¼" to 3½". Ratios can be furnished from 3-5/9:1 to 100:1 . . . For prompt response from H&S engineers, just send an outline of your needs.

THE HORSBURGH & SCOTT CO.
GEARS AND SPEED REDUCERS
5112 Hamilton Avenue
Cleveland 14, Ohio

For more information circle No. 27 on the Reader Service Card

Rotary actuator

Unit operates under a normal load of 8 inch-lbs at 1000 rpm. Use of the next larger size motor



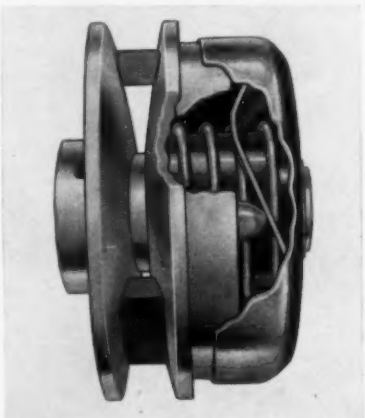
permits loads up to 30 inch-lbs at 200 rpm. Adjustable travel-limit mechanism allows as many as 250 turns of output shafts. Featured is an adjustable electrical load-sensing device which stops the unit in one direction and holds a predetermined load automatically. Holding-load range adjusts from 6 inch-lbs to 17 inch-lbs. Motors for 400 cycle operation, single or polyphase, and other d-c voltage are available.

The Hoover Electric Co., Los Angeles, Cal.

Circle No. 205 on Reader Service Card

Vari-speed pulleys

Constant speed regardless of wide load-variations is accomplished by a cam which automatically maintains required belt tension for a given load.



Compact in diameter and length, they are available in the following hp ratings: ½ hp, ¾ hp, and 1 hp, at 1750 rpm. Speed ratios vary from 2:1 for the ½ hp and ¾ hp models, to 2½:1 for the 1 hp model.

Continued on page 62

SHAFTS *continued*

should be multiplied by

$$\frac{20}{\sqrt[3]{(s_s)'_{max}}}$$

Problem 1

What is the OD of a hollow circular steel shaft stressed to 8000 psi max carrying a torque of 1,000,000 lb-in. if $d_i/d = 2/3$?

Solution

From curve 3, see intersection of vertical line through $d_i/d = 0.667$ with torque curve marked 1,000,000 lb.in.

$d = 9.25$ in.

What is the diameter if a safety factor of 2 is introduced?

$$d = 9.25 \times \sqrt[3]{\frac{20}{4000}} = 11.7 \text{ in.}$$

Problem 2

Find the maximum safe torque that can be applied to a hollow circular shaft

$4\frac{1}{8}$ OD × 2-1/16 in. ID $(s_s)max = 8000$ psi.

Solution

From curve 3,

$d_i/d = 0.500$ and $d = 4.125$

T max = 100,000 lb-in.

Problem 3

What should be the d_i/d of a hollow circular steel shaft in order that it will be not less than 10% weaker than a solid shaft of the same diameter and length?

Solution

From curve 2, for 90% of original strength, $d_i/d = 0.55$ for the same loading. The corresponding reduction in weight is 31%.

Problem 4

Compare the weight of two shafts—one solid, 4-in diameter, the other hollow, $d_i/d = 0.8$. Both carry the same torque of 10,000 lb-in. and have the same $(s_s)max$ of 8000 psi.

Solution

From curve 3,

for $d_i/d = O$, T = 10,000 lb-in, d = 1.85 in.

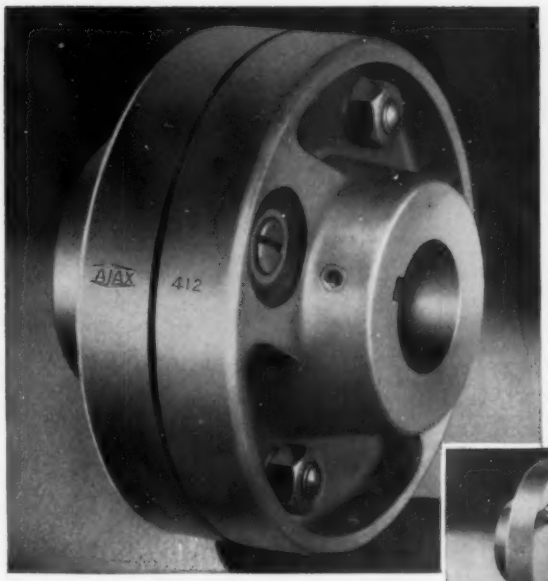
for d_i/d 0.8, T = 10,000 lb-in., d = 2.25 in.

$$A_{solid}/A_{hollow} = \frac{(1.85)^2}{(2.25)^2\ (1 - 0.8^2)} = 1.875{:}1$$

which is the same as the weight ratio if both are of the same length.

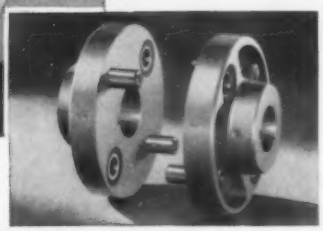
Nomenclature

d = outside diameter, in.



Left: Periphery and face of Series 400 flanges are machined to simplify lining up with straight edge or feeler gauge.

Below: Separated halves show arrangement of 4 drive studs and rubber cushioned sleeve bearings.



AJAX ANNOUNCES

NEW *Series 400*

Normal Duty Flexible Couplings

at New Low Cost

● Original equipment manufacturers and plant engineers can now have the protection of AJAX positive resilient drive for direct-connected machines at minimum cost.

New AJAX Series 400 rubber cushioned flexible couplings are particularly suited to connect motors directly to pumps, fans, mixers, speed reducers, light duty hoists, compressors, and other machines with average torques in relation to shaft diameters.

The performance of new AJAX Series 400 Couplings is based on the same proven design which has been giving satisfaction in hundreds of thousands of installations for 40 years.

Their 4 steel studs and sleeve bearings require no lubrication. Rubber cushions absorb unavoidable misalignment, and their resiliency provides a quiet cushioned drive in both directions of rotation.

AJAX Series 400 Flexible Couplings are made in 4 sizes with 1¼", 1¾", 2¼", and 2¾" maximum bore respectively with standard square keys.

Mail coupon for Catalog 67.

AJAX

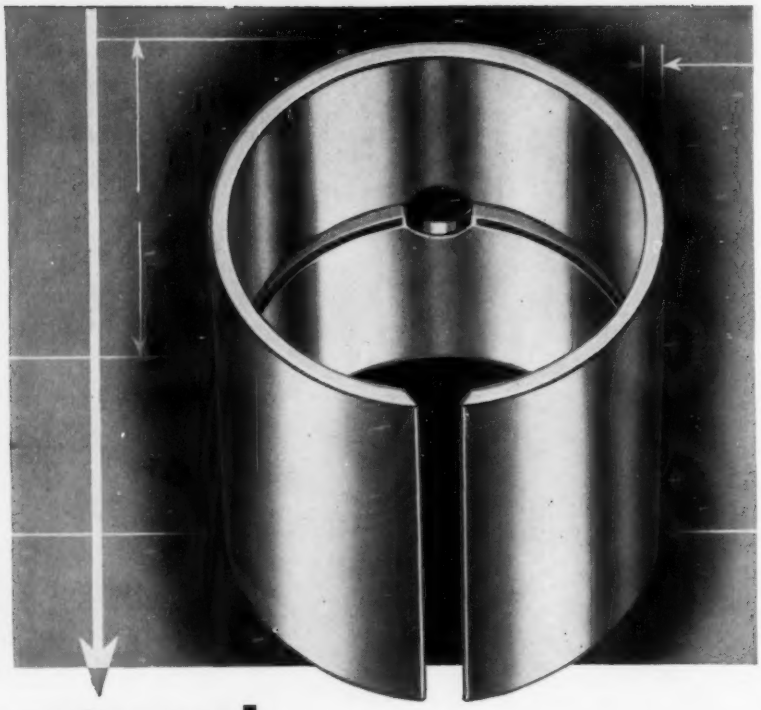
AJAX FLEXIBLE COUPLING CO., INC.
132 Portage Road, Westfield, N. Y.
Send Catalog 67 on Series 400 Couplings.

Name_____

Concern_____

Address_____

For more information circle No. 29 on the Reader Service Card



extremely rigid specifications!

The illustration shows the cast bronze spindle bearing of a very well-known and popular metal-working lathe.

The manufacturer of this lathe has extremely rigid specifications covering tolerances, finish, structural quality of the bronze and roundness of the bearing even though the bearing is split for its entire length.

A manufacturer with such requirements naturally turns to Bunting to satisfy them.

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SHAFTS *continued*

d_i = inside diameter, in.
N = safety factor
r = radial distance from polar axis, in.
T = torque, lb-in.
(s_s) max = maximum shearing stress, psi
$(s_s)'$ max = maximum allowable shearing stress, psi $(=(s_s)\ \text{max}/N)$
Z = section modulus, in.^{3} (J/r in torsion).

Killian at H. K. Porter

Stanley C. Killian is newly appointed vice president and general manager, Delta-Star Electric Div., H. K. Porter Company Inc., Chicago. He served on the division executive staff for six years, most recently as vice president and assistant general manager, and previously as chief engineer. C. Stuart Beattie, who for the last eight years operated Delta-Star, continues in a part-time consulting capacity.

Heads Worthington Corp. sales

LARAMY

New manager of the Worthington Corporation of Harrison, New Jersey, Jack Laramy, joined the firm in 1929, following graduation from the University of Michigan.

He served as general line salesman, then as assistant manager of the Chicago office. In 1951 he was appointed manager of Worthington's Marketing Research Dept. He has served as Eastern Regional Sales Manager and Assistant Manager, Marketing Division, for the past three years.

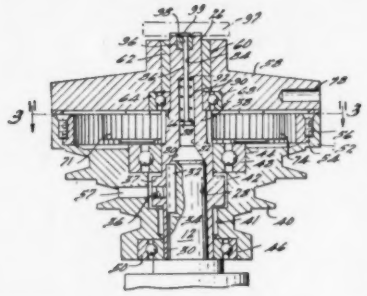
At the present time, Laramy lives in the City of Caldwell, New Jersey.

AC appoints Rausch

AC Spark Plug Div., Flint, Mich., General Motors, appointed John T. Rausch assistant chief engineer in charge of the motor group of products. He succeeds Dr. Wilfred A. Bychinsky, recently made chief automotive engineer at AC.

PATENTS

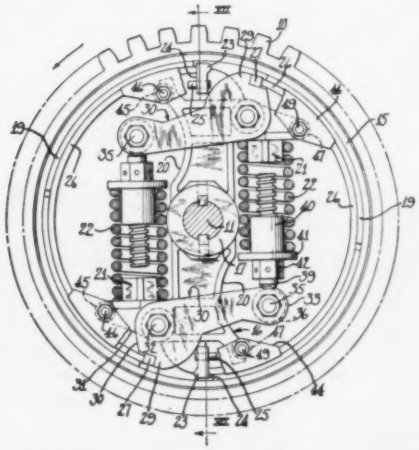
Variable-Speed Geared Pulley



U. S. Patent No. 2,856,797. Carroll F. Dassance, St. Clair Shores, Mich.

Planetary gear train built into a double pulley body may be engaged or disengaged so that the output pulley turns at the same speed as the input pulley, or the planetary gear reduction is in effect. A key either locks the input pulley shaft to the planetary carrier or to the sun gear to give the two conditions.

Controlled Torque Device



U. S. Patent No. 2,859,601; Charles E. Evans, Du Page County, Ill., assignor to Barber-Greene Co., Aurora, Ill.

Driving and driven members are connected by a friction drive. Torque is transmitted from the driving member to the driven member by

Continued on next page

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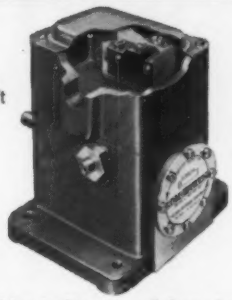
NEW ROTO-GUARD*
SHAFT MOTION INDICATOR



PROVIDES positive indication of drop in speed or stopping of machinery
PROTECTS conveyors • elevators • feeders • belt conveyors
OPERATING SPEEDS of 10 to 150 rpm make the **ROTO-GUARD** applicable to automatic protection of slow-moving machinery used in material handling and similar systems
RUGGED AND COMPACT: approx. 5" x 6" x 6".

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- Self-Adjusting
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Stearns ELECTRIC CORPORATION
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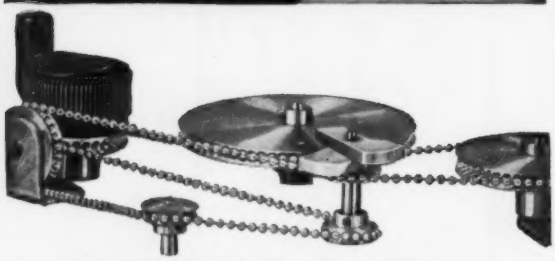
FOR POSITIVE, LOW-COST SPROCKET DRIVES . . .

TRY GENUINE BEAD CHAIN



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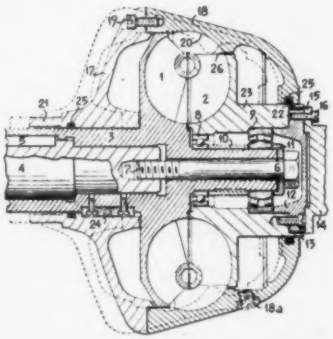
a tight end taking the driving torque and the opposite slack end. A spring loads the tight end and torque is transmitted through the spring. As torque increases, the spring compresses and decreases pressure on the slack end until pressure on the slack end of the friction member is reduced to the point where slippage occurs.

Fluid Coupling



U. S. Patent No. 2,851,858; Bruno C. Grosskopf, Hamburg-Othmarschen, Germany, assignor to Ateliers des Charmilles S. A., Geneva Switzerland.

Closed-circuit type fluid coupling is made up of an outer casing, pump wheel and turbine wheel within the casing. Outer casing is driven by the pump wheel and can slide axially with it. A portion of the casing can be extended between the outlet of the pump wheel and the inlet of the turbine wheel and is axially movable with respect to both. This portion of the casing serves as a guide for the fluid medium and can be used to constrict the fluid passages and thus serve to control torque transmitted.

Clutch Facing

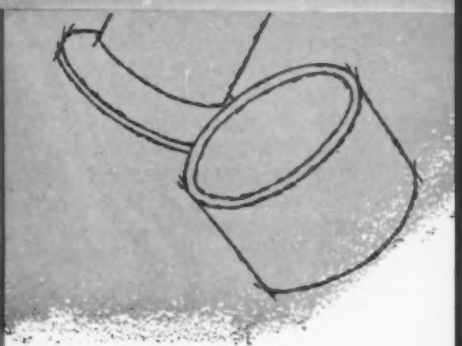
U. S. Patent No. 2,855,081; Henry C. Morton, Branford, Conn., assignor to The Russell Mfg. Co., Middletown, Conn.

Facing for attachment to a clutch plate is made up of a perforated-metal reinforcing disc with friction facings of compressed, spirally-wound, fabric tape. Tape is made from spun asbestos, cellulose fiber, and wire impregnated with a heat-hardenable bonding resin. Tape and bonding resin go through the perforations in the reinforcing unit to bond the unit together.

BEARINGS

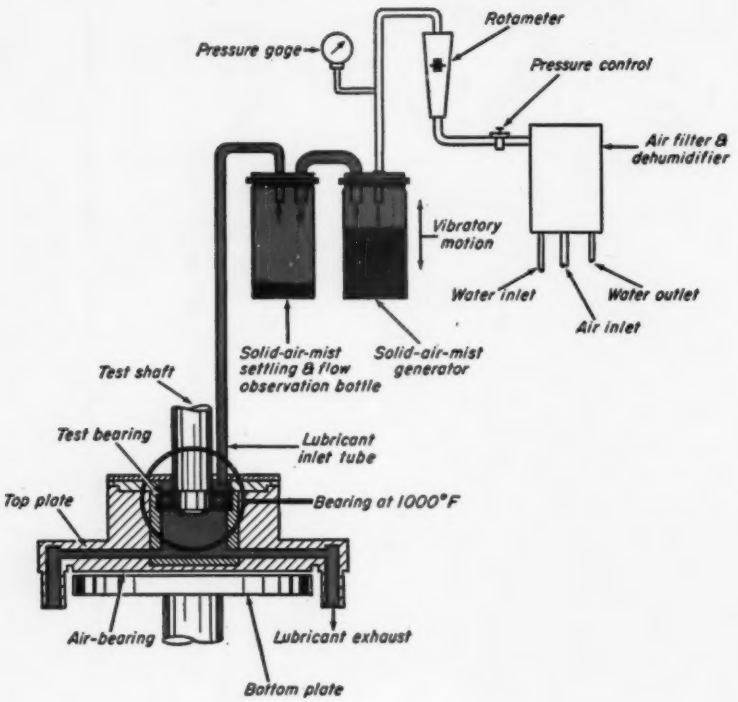
DESIGN/APPLICATION

REGULAR MONTHL
SECTION OF IDEA
AND DEVELOPMENT



POWER TRANSMISSION DESIGN

March 1959



Ever try graphite as a bearing lubricant? Its effectiveness depends on its ability to adhere to surfaces being lubricated. Adherence is improved by the presence of surface oxide film. This film is promoted by oxygen and water vapor in the carrier.

How to lubricate bearings with graphite

By **Z. N. NEMETH** and **W. J. ANDERSON**, *Lewis Research Center, National Aeronautics and Space Administration*

GRAPHITE CAN BE SUCCESSFULLY used as a lubricant for antifriction bearings up to 1000°F and over. There are certain limitations and conditions that must be met in order to assure sustained operation. Chief of these is the type of carrier atmosphere and method used in presenting the graphite to the bearing area.

Let us test an example bearing and follow it through several different situations under different carrier conditions.

Let's run it at 2500 rpm with 110 lb thrust load. Various carrier atmospheres will be: air, dry air, pre-purified nitrogen, and moist pre-purified nitrogen.

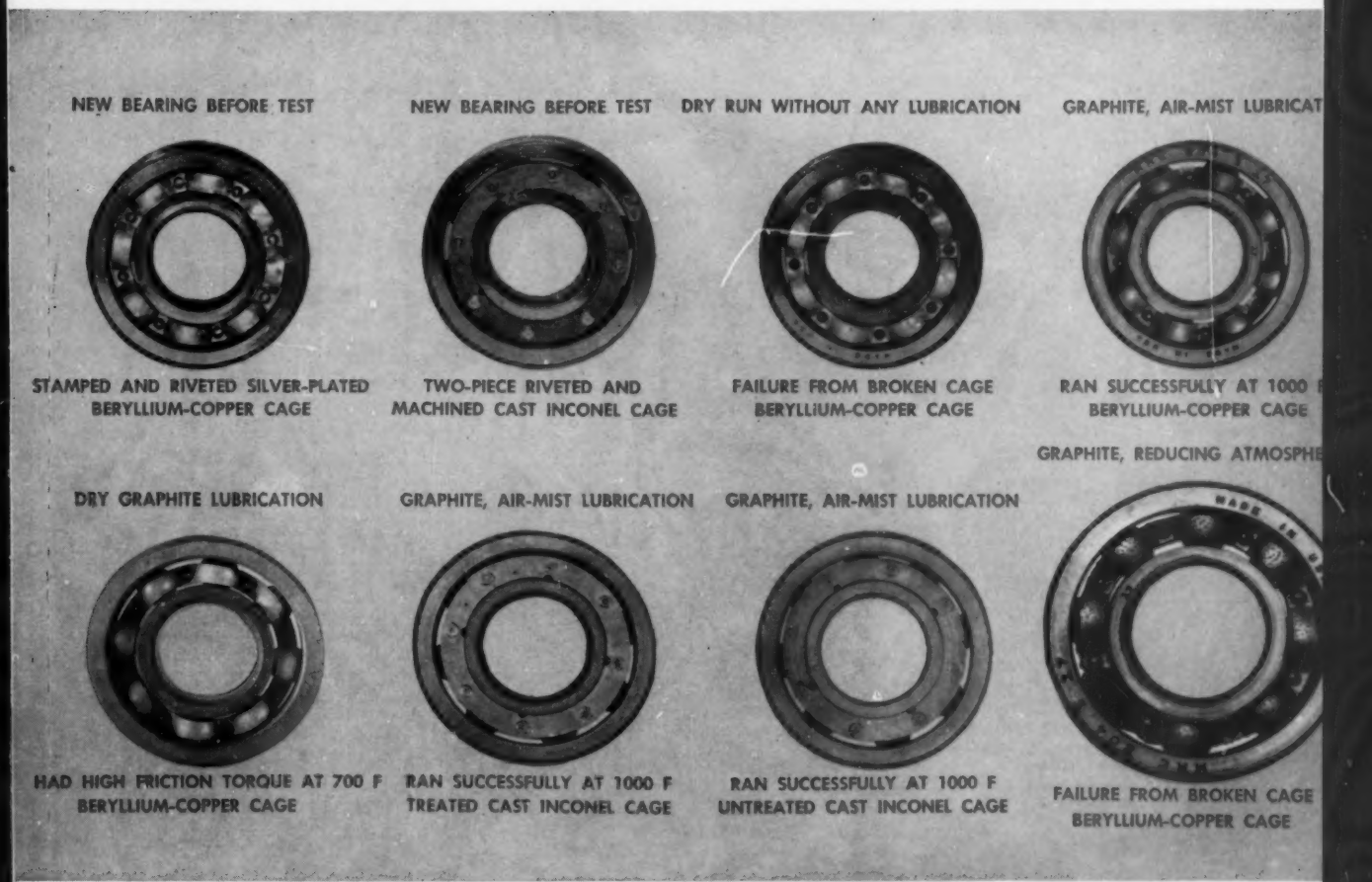
The bearing is size 204, with a 20 mm bore, 14 mm width, 47 mm OD. It is made of 18-4-1 high-speed tool-steel, 18% tungsten, 1% vanadium and 4% chromium. It is constructed with a nominal 0.0004 in. diametral clearance to ABEC-3 tolerances.

The cage is made of two-piece stamped and riveted silver-plated beryllium-copper; or it can also be made of two-piece machined and riveted cast Inconel. Cast Inconel has desirable high-temperature-resistant qualities. The Inconel cages may or may not be treated with a bath of molten sodium hydroxide NaOH at approximately 750°F for three hours to produce a nickel oxide coating which gives it improved wear resistance.

Let's measure friction torque with a calibrated force-measuring transducer which restrains the bearing housing, mounted on an air-thrust bearing, from moving (shown in drawing). The air thrust bearing does not introduce any friction torque during operation; the torque measured is only that of the test bearing. Friction torque is recorded on photoelectric potentiometer recorder.

The test rig consists of a resistance furnace, spindle, bearing housing, lever system with dead weight loads and thermocouple temperature-measuring elements.

The bearing is mounted on a short shaft. The outer race is mounted in a special Inconel housing in the furnace cavity. The assembly is


NEW BEARING BEFORE TEST
STAMPED AND RIVETED SILVER-PLATED BERYLLIUM-COPPER CAGE
NEW BEARING BEFORE TEST
TWO-PIECE RIVETED AND MACHINED CAST INCONEL CAGE
DRY RUN WITHOUT ANY LUBRICATION
FAILURE FROM BROKEN CAGE BERYLLIUM-COPPER CAGE
GRAPHITE, AIR-MIST LUBRICAT
RAN SUCCESSFULLY AT 1000
BERYLLIUM-COPPER CAGE
GRAPHITE, REDUCING ATMOSPHE
DRY GRAPHITE LUBRICATION
HAD HIGH FRICTION TORQUE AT 700 F BERYLLIUM-COPPER CAGE
GRAPHITE, AIR-MIST LUBRICATION
RAN SUCCESSFULLY AT 1000 F TREATED CAST INCONEL CAGE
GRAPHITE, AIR-MIST LUBRICATION
RAN SUCCESSFULLY AT 1000 F UNTREATED CAST INCONEL CAGE
FAILURE FROM BROKEN CAGE BERYLLIUM-COPPER CAGE

to 1000 degrees F

mounted so that the externally pressurized air-thrust bearing provides a frictionless support to permit accurate measurement of friction torque at all temperatures.

The furnace consists of an Inconel cylinder heated with Nichrome wire coils wound around the outside and controlled with an automatic controller.

Outer race temperature is measured with an iron-constantan thermocouple located in the bearing housing. An additional thermocouple for control is also mounted in the housing. A special 3-ft section of very fine gage wire is hung vertically from the housing to minimize friction-torque effects of the thermocouple.

The inner race temperature is also measured with an iron-constantan thermocouple pressed against the inner race bore at the axial mid-point of the bearing. The wires are taken out through a hole in the center of the spindle. The emf signals are transmitted from the spindle through small slip rings as the spindle rotates.

An air-mist lubrication system conveys the graphite into the bearing area. It consists of a low-pressure air supply, pressure regulating valve, float-type rotameter, combination dehumidifier and air filter, two 4-oz bottle, vibrator for the bottles, and a section of 3/16-inch stainless steel tubing. The tubing carries the solid-air-mist lubricant into the bearing.

The air is filtered through a 2-micron filter and dried. For tests with dry air, an activated-alumina adsorption air-drier is used. Dew point of the air is kept lower than —60°F. Pressurized air is introduced to the upstream bottle to agitate the graphite power and carry it downstream. The second bottle acts as a trap for excessively large particles and as a visual gage for determining flow rate. Both bottles are vibrated to keep the powder mobile.

During operation, the bearing runs at a constant 2500 rpm. The 110 lb thrust load is maintained throughout the entire temperature range of 100°F to 1000°F of the outer race. These temperatures are raised in increments of 150°F. The bearing runs continuously during the time required to reach the next temperature levels, and then continues for at least two hours at that level.

With solid air-mist graphite lubrication, the bearing is very sensitive to flow. That is, an insufficient flow produces symptoms of incipi-

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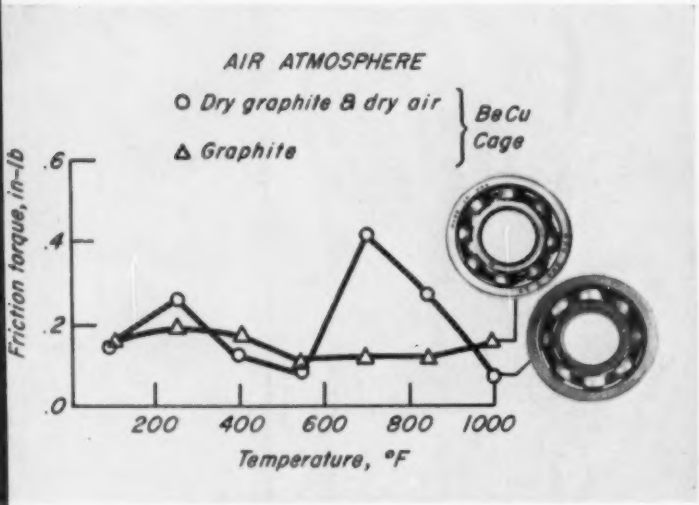
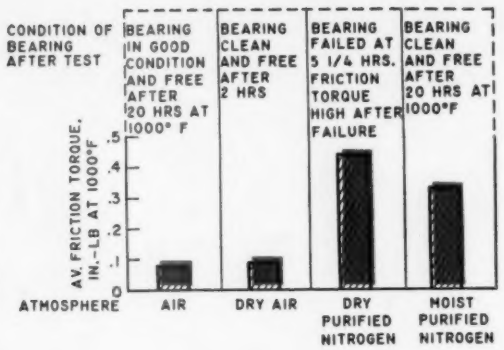




TEST RESULTS SHOW that graphite can be used successfully at 1000°F with different types of carrier atmospheres. Presence of moisture or oxide film is always necessary for good lubrication.

Test No.	Lubricant[b]	Atmosphere	Average bearing torque, in-lb. 700 F.	1000 F.	Remarks
1[a]	Synthetic graphite	Air	0.06	0.08	Completed two hrs. at 1000 F. Bearing very clean and free. Negligible wear. Total running time, 18.65 hours. Test run at 100 to 1000 F.
2[a]	Dry synthetic graphite	Dry air	0.42	0.09	Completed two hrs. at 1000 F. Bearing clean and free. Total running time, 18.5 hours. Test run at 100 to 1000 F.
3[a]	Synthetic graphite	Air		0.03 to .13	Completed 20 hrs. at 1000 F. Bearing in good condition and free. Test run at 1000 F.
4	Synthetic graphite	Prepurified nitrogen		0.44 (1.75 at failure)	Bearing failed after 5.25 hrs., cage not broken, however. Friction torque high after failure. Test run at 1000 F.
5	Synthetic graphite	Moist prepurified nitrogen		0.28 to .38	Completed 20 hrs. at 1000 F. Bearing clean and free. Test run at 1000 F.

insufficient flow produces symptoms of incipient failure; excessive flow causes a grating sound and increase in friction torque. Flow must be adjusted to minimize this.

Flow rate is therefore established at 2×10^{-5} to 15×10^{-5} lb/min. Air flow required to carry the solid particles was established at approximately 0.053 to 0.23 cu ft/min.

Failure at any time is characterized by high and unstable torque readings exceeding 0.5 inch-lb. and also noisy operation. If only the cage fails, it is detected by visual inspection.

In one test, when the bearing was operated dry, without any lubrication, failure usually occured after about 3 hrs and 6 min. Friction torque increased momentarily after 1-hr and 24-min. The bearing began to fail after 2-hrs and 55-min; and about 10-min later, friction torque rose rapidly from 0.4 to 4.75 inch-lb. The cage broke and the inner race, balls and cage became slightly discolored from heat to a light straw shade. At time of failure, the inner race temperature was approximately 540°F, which is 290°F higher than the outer race. This temperature differential produces the high load between the balls and races because diametrical clearance is lost. It is this loss of clearance that probably causes the cage to break.

When operated with sufficient graphite and air-mist, friction torque in general decreases with temperature throughout the entire range to 1000°F. At 1000°F, torque is very low ranging from 0.1 to 0.15 inch-lb. The bearing is clean on teardown except that it is covered with a fine graphite powder.

When operated with dried graphite and specially dried air instead of ordinary supply air, it becomes evident that graphite depends greatly on the presence of moisture, or certain gases. Graphite in the absence of moisture is not as effective as when present. Although torque is higher for dried air than when non-dried graphite is used, the bearing will continue to run.

Between 700°F and 1000°F, torque drops considerably. This reduction is probably caused by oxidation of the bearing surfaces and better graphite adhesion. At the end of the test, the dried-graphite bearing appearance is usually comparable to the test with moisture present.

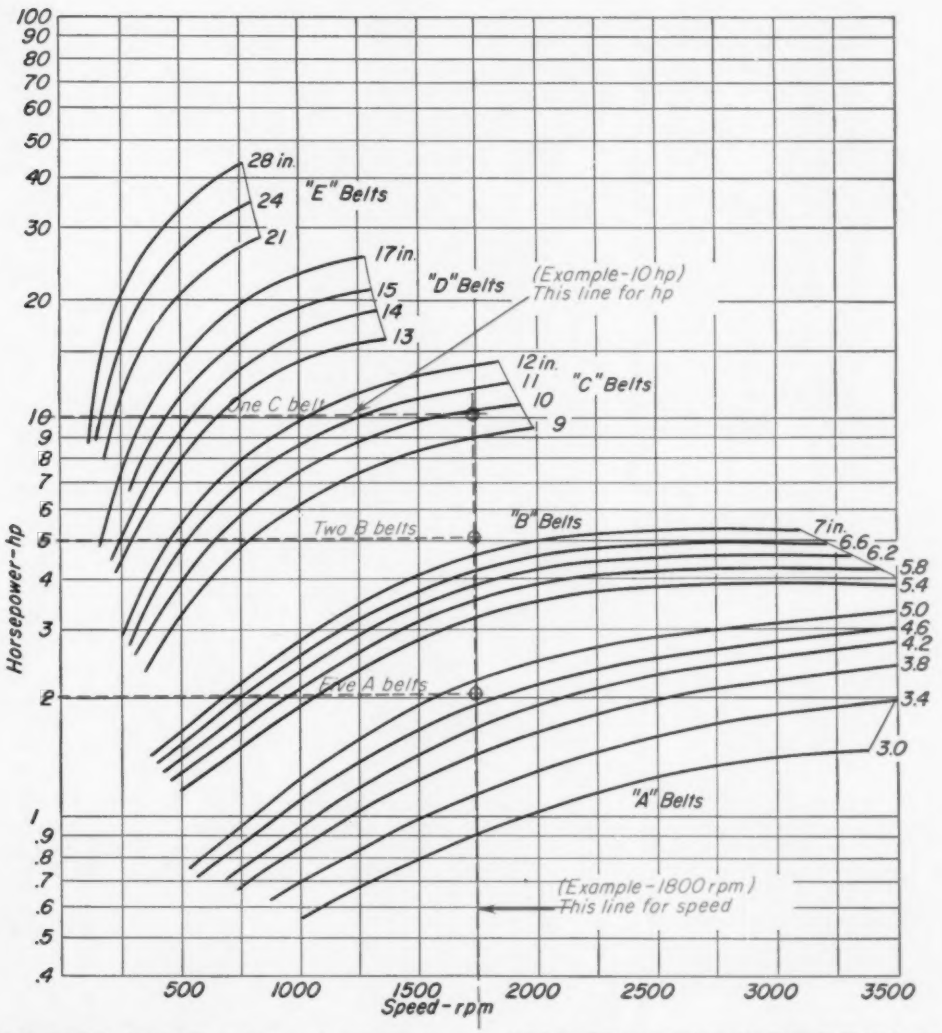
Cast Inconel Cages

With an oxide-coated cast Inconel cage and graphite-air lubricaton, friction torque is quite high and unstable, reaching a maximum value at 850°F. However, torque drops when approaching 1000°F. This may be caused by an increased rate of formation of nickel-oxide on the surface of the cage. At 1000°F, torque ranges from 0.2 to 0.36 inch-lb. These values are higher than when beryllium copper is used. Cast Inconel is satisfactory, however.

With untreated cast-Inconel and graphite-air mist friction values are comparable to those of the beryllium copper. A slight reduction in torque between 700°F and 1000°F is noted over an oxide-coated cage. The test is successful.

Nomogram of A, B, C, D and E V-belts

By **GEORGE B. RICHTER,** instructor, University of Minnesota



EXAMPLE: LET'S SELECT V-belt and pulleys to be used on an 1800 rpm motor to transmit approximately 10 hp to a 600 rpm shaft. Solution: Read across dotted line from 10 hp and up dotted line from 1800 rpm. Answer: One C V-belt on a motor pulley of 9.3 in. PD or greater; Or, Two B V-belts by reading across dotted line from 5 hp which is half the total for each belt; Or, Five A V-belts by reading across dotted line from 2 hp which is one-fifth total for each of five belts. Never use smaller sizes than shown.

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1/3 TO 5 HORSEPOWER INPUT

Plus Features for Plus Service
• Strong, tough cast iron housings insure exact and permanent gear alignment, rigid bearing support.
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• Alloy steel worm and shaft . . . carburized, hardened and ground.
• Extra capacity ball radial and thrust bearings on worm shaft; tapered roller bearings on worm gear shaft.
• Improved neoprene spring backed lip seals on shafts.
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Advanced worm gear design and Foote Bros. precision production techniques make these new Hygrade Reducers the most efficient and economical power packages you can buy. And they're easier to select and buy, because Foote Bros. Distributors and Branch Warehouses carry them in stock ready for immediate delivery.

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NEW PRODUCTS

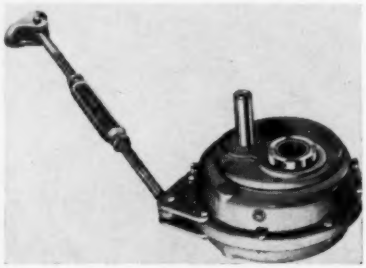
continued from page 52

Lovejoy Flexible Coupling Co., Chicago, Ill.

Circle No. 224 on Reader Service Card

Shaft mounted reducer

Shaft mounted gear reducer eliminates need for motor bases, rails, supporting structures, and flexible couplings. Eighteen single and double reduction models are supplied from stock. Single reduction types are 98% efficient, affording 4.5:1 speed ratio. Horsepower: from fractonal hp to 120-hp. Output speeds range from 8 rpm to 425 rpm. Installed direct to driven shaft, can be mounted vertically or at an angle. Hollow shaft bores range from 1 7/16 inches to 5-15/16 inches.

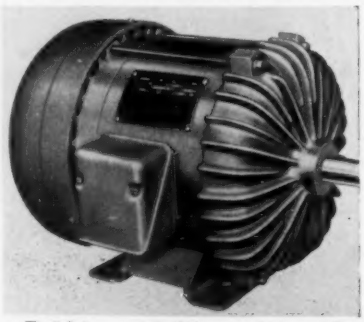


Lovejoy Flexible Coupling Co., Chicago, Illinois.

Circle No. 223 on Reader Service Card

Single phase motors

Single phase motors in fan-cooled, explosion-proof, totally enclosed frames, are available in 2, 4, and 6 pole speeds. The motors are built into re-rated NEMA frames 182, 184, 213, and 215. Ratings range from ¾-hp to 5-hp. Condensers and centrifugal mechanism used are enclosed within the front-end head.

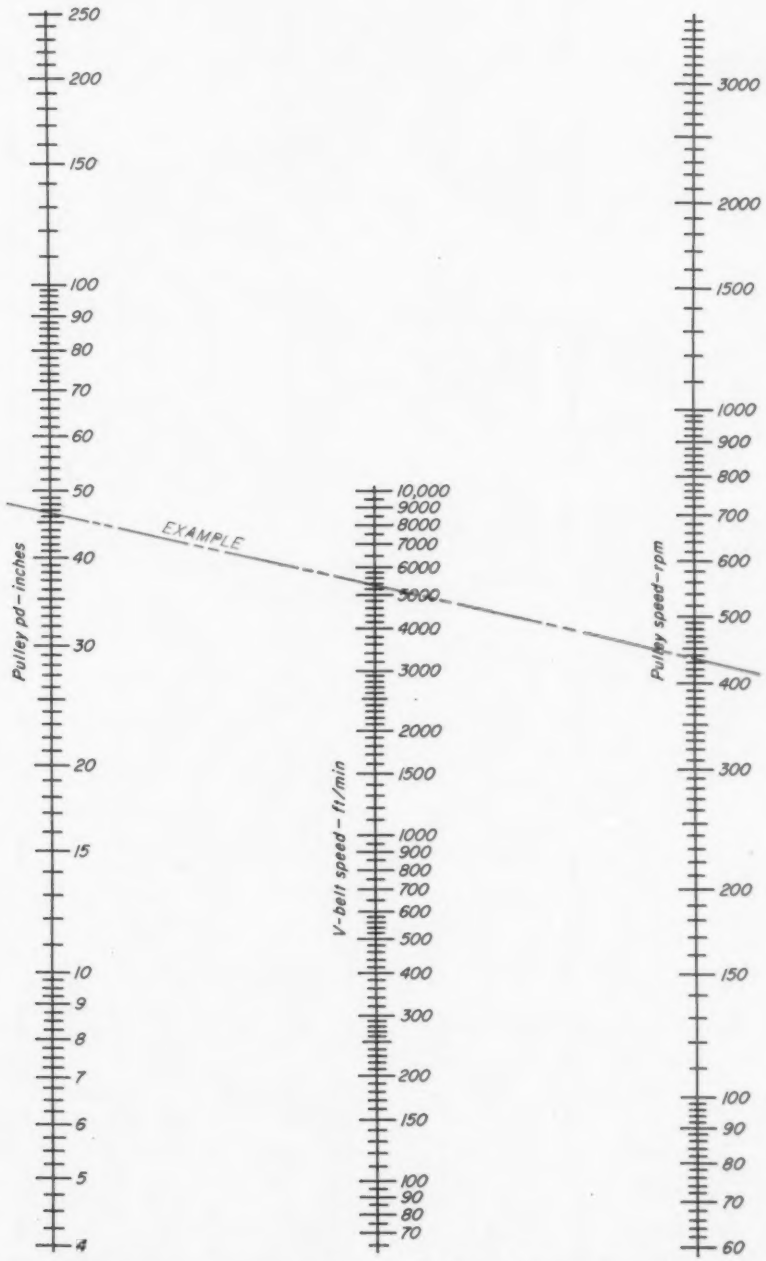


Robbins and Myers, Inc., Motor Division, Springfield, Ohio.

Circle No. 208 on Reader Service Card

Nomogram of V-belt and pulley speed

Courtesy **GRATON AND KNIGHT CO., INC.**



PLACE STRAIGHT EDGE across nomogram to intersect all three ordinates. Read directly—pulley pitch-diameter, inches; V-belt speed, ft/min; or pulley speed, rpm. Two values will produce third.

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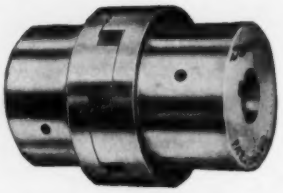
Specify the Coupling that lives a DOUBLE LIFE...

The BONDTRU Coupling has double life. When the coupling is operating in one direction only, every second arm of the insert carries a load, while the remaining arms serve to prevent backlash. Should the load carrying arms become worn through long use, the insert can be moved up one position, putting in place the other set of arms which have remained unimpaired.



Patent No. 2,003,848
Canadian Patent No. 295,340

BONDTRU

Flexible

INSULATED COUPLING

The BONDTRU Coupling can be adapted with complete satisfaction to practically any application where a flexible connecting medium is required to transmit from 1/4-h.p. up to 100 h.p. at 100 r.p.m.

EASY ON BEARINGS—The self-aligning feature of the BONDTRU Coupling minimizes wear on the bearings by compensating for both lateral and angular misalignment of the driving and driven shafts.

NO MAINTENANCE NEEDED—Another advantage of the BONDTRU is that it has no moving parts—nothing that needs lubrication.

For complete information on Bond Flexible Insulated Couplings, write for Catalog No. 100.

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BOOKS

Design Manual, Roller and Silent Chain Drives

Prepared by Jackson and Moreland for the Association of Roller and Silent Chain Manufacturers, Publishers. Second printing; Price: $3.50.

A must for every engineer in the power transmission design field. Chapter headings include such titles as: "Design of Roller Chain Drives," and "Roller Chains and Sprockets, Design Principles".

Well illustrated, the book shows such things as the detail design of tooth-forms together with photos of modern, up-to-date power transmission applications. The section headed "Comparison of Mechanical Power Drives" discusses chains, belts, sprockets and gears. Adding to general interest is the opening section on "The History of the Chain Drive".

Gear Design Simplified

By Franklin D. Jones; contains 201 drawings, 134 pages; published by The Industrial Press, 93 Worth St., New York 13, New York; Price: $4.50.

Here is the answer to many puzzling problems of gear design which bother the engineer and designer. This is a well planned, well laid out book. It is in chart form, containing 110 charts outlining and explaining gear problems. A series of carefully chosen, worked-out examples of gear design illustrate how rules are applied so as to obtain design essentials.

These necessary items include dimensions. Also shown are various angles. These things are written in a way that allows easy understanding and useful application. A fine book for the engineer coping with problems in gear construction, application, and gear design.

Insulated Cable coverings

"American Requirements Standard for Metallic and Associated Coverings for Insulated Cables." Published by the National Electrical Manufacturers' Association, NEMA Publication No. WC-21958. Available at 155 East 44 St., New York 17, New York; Price: $1.00.

This is a joint ASA-IPC A-NEMA publication. It covers metallic and other associated coverings which are recommended for use under normal conditions of installation.

Also included are recommendations for use under normal operation and power-maintenance of communication, control, and lighting wires and cables insulated with asbestos, im-

pregnated paper, and rubber or rubber-like compounds.

Also covered is round-wire armor for buried, dredge, shaft, and vertical riser cable. This volume is a proven asset to designers and engineers in most phases of the power transmission field. As a reference source, its value is inestimable. The subjects covered have a direct relationship to design and development of power transmission.

Ingenious Mechanisms for Designers, Inventors

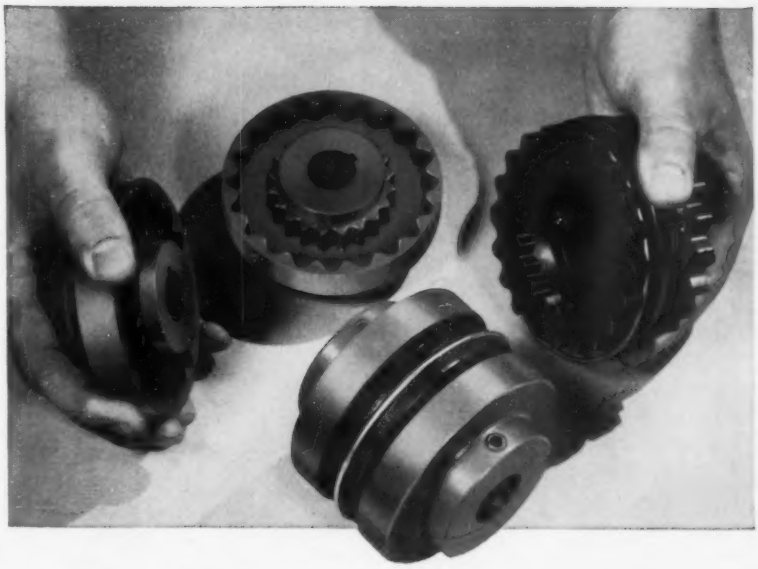
By F. D. Jones and Holbrook L. Horton. Jones authored Volumes I and II of the set, Holbrook conceived volume III. Published by The Industrial Press, 93 Worth St., New York 13, New York; Price: $6.50 single volume, $16.00 per set.

An encyclopedia of mechanical movements. Each volume is an independent treatise on the subject of mechanisms. Although each of the three is similar in size and general character, contents are different. Each is filled with instructive illustrations.

Motors and Generators

Published by the National Electrical Manufacturers' Association, NEMA Publication No. MG-1-1958. Available at 155 East 44 St., New York 17, New York. Revised edition, Price: $10.00.

This revised edition has been broadened so as to offer greater detail to its users. Divided into 14 separate parts, coverage extends over many of the most important areas of the power transmission field. They are: Part 1, Definitions; Parts 2 to 6, inclusive, Ratings, Dimensions, Test Characteristics, application data for fractional and integral horsepower motors rated 200-hp and less; Part 7, Definite-purpose motors; Part 8, Synchronous motors; Parts 9 and 10, D-C generators; 11, Synchronous generator sets; and 14, A-C induction motors larger than 200-hp.



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Friction and fluid drives
Bulletin 314, 20 pages, gives condensed specifications, engineering data, schematics, and dimensions. The wide range of products described includes: friction clutches, mechanical and air actuated; power take offs; reduction gears; fluid couplings; torque converters, single and three-stage and marine gears.

Twin Disc Clutch Co., Racine, Wisconsin.

Circle No. 109 on Reader Service Card

D-C Motor
Describes 2-hp, 28 volt, 3000 rpm d-c motor. Normal operating range is from .8-hp to 3-hp. Other features described are: integral cooling fan, integral gear reduction, brushes easily accessible. Applications pointed out include: aircraft, missiles, ordnance, marine, and industrial.

The Hoover Electric Co., Port Columbus, Ohio.

Circle No. 110 on Reader Service Card

Instrument bearings
Catalog 59, 26 pages, lists complete tabular data as a guide in bearing selection. Bearings are described as made of 52100 high chrome alloy, standard retainer is stainless steel.

Split Ball Bearing, Lebanon, New Hampshire.

Circle No. 111 on Reader Service Card

Bonded mountings
Four-page bulletin No. 712, describes vibration isolation and heavy shock absorption features. Also includes data on patented design features, installation, performance, and specifications of both compression and shear type mountings. Bonded mountings are used for flexible suspension systems in mobile transport mounted equipment subjected to shock. Are readily adaptable to base or frame

LITERATURE

on machine drives and related components

mounted transfer cases, radiators, engine generator sets, and others.

Lord Mfg. Co., Erie, Pennsylvania.

Circle No. 114 on Reader Service Card

Brake blocks

Two-color bulletin outlines main points of sintered ferrous metal brake blocks. Cross-section view of item shows that same forward and reverse blocks insure uniform friction action and illustrates solid steel backing of heavy gauge carbon steel. Advantages include: longer drum wear, fewer adjustments, quiet stops, and low cost.

The S. K. Wellman Co., Bedford, Ohio.

Circle No. 113 on Reader Service Card

Needle thrust bearings

Catalog No. 759 discusses installation, lubrication, and load capacity. Also, design, and installation of thrust races used with them. Bore sizes range from 3/8-inch to 3-inches. Included is list of thrust races for use with these bearings.

Torrington Co., Torrington, Connecticut.

Circle No. 115 on Reader Service Card

Centrifugal switches

Precise speed sensing by centrifugal switches, added to the ability to indicate slipping belts, broken belts, or belt stoppage, are described in Bulletin 2210, 8 pages, two-colors. Tabular data includes information on snap-action precision switch type, non-directional contacts for A-C and D-C; and slow action, butt type non-directional contacts, A-C and D-C.

The Euclid Electric and Manufacturing Co., Madison, Ohio.

Circle No. 116 on Reader Service Card

Flexible shafting

Designing a flexible shaft into products having an application which requires control from remote places is explained in 8 page bulletin which also has information on the use of adapters for flexible shafting. Included are specification charts on remote control and power drive cables, plus charts of casing materials.

The F. W. Stewart Corp., Chicago, Illinois.

Circle No. 117 on Reader Service Card

High speed gears

Gears, less than one inch in diameter to more than 200 inches in diameter, with tooth-to-tooth spacing of 0.0002-inches are described in 24 page bulletin No. GEA-6430. Applications include high speed industrial gear units, marine gear units, aircraft power and accessory gears, rocket and missile gears, radar power and data gears, guidance control gears, gun positioning gears.

General Electric Co., Schenectady, New York.

Circle No. 118 on Reader Service Card

Flexible couplings

Specifications for three standard shear-type flexible couplings are listed in six page flexible coupling bulletin No. 205. Horsepower ranges from 1/50-hp to 100-hp, at 1750 rpm. Also given, the formula for selecting correct standard couplings for other speeds. Custom-engineered flexible couplings are illustrated; necessary data for designing or choosing couplings is listed.

The Lord Mfg. Co., Erie, Pennsylvania.

Circle No. 119 on Reader Service Card

Integral shaft sheave

Construction and operation features of integral shaft sheaves for low-cost, stepless speed control in large machines are given in bulletin No. 20B7897B. Sheaves provide a wide range of speeds, infinite speed variations, and accurate speed control while the drive is in motion. Design allows mounting of the sheaves between two pillow blocks for rigid support.

Allis-Chalmers Mfg. Co., Milwaukee, Wisconsin.

Circle No. 120 on Reader Service Card

Gear precision checker

Small precision gears, gear hubs, flat bearing surfaces, close-tolerance demands on special sprockets, all can be checked to hair-fine accuracy with the inspection device described in well illustrated, 8 page folder. Inspecting flatness by reflection, the unit concentrates helium on the work surface. Measures accuracies less than 0.000005-inches.

Cartriseal Corp., Lincolnwood, Illinois.

Circle No. 121 on Reader Service Card

Clutch pulleys

Variable speed clutch pulleys, their use, how they work, and how to select them. These subjects are listed in 4-page Bulletin No. 1 M. In selecting clutches, example given is: 5-hp, 400 rpm. Letter indicated on the tabular chart is model number B. Checking shows model B is a 15-18-1AC clutch.

The Horton Mfg. Co., Minneapolis, Minnesota.

Circle No. 122 on Reader Service Card

Miniature Coupling

One page bulletin on miniature flexible coupling called "Gear Grip 5-G." Has standard overall length of 0.740 in. Available with 4/40 set screws, is electrically insulated and weighs 1½ grams.

Guardian Products Corp., Michigan City, Ind.

Circle No. 154 on reader service card

Continued on page 71

ABSTRACTS

of current technical papers

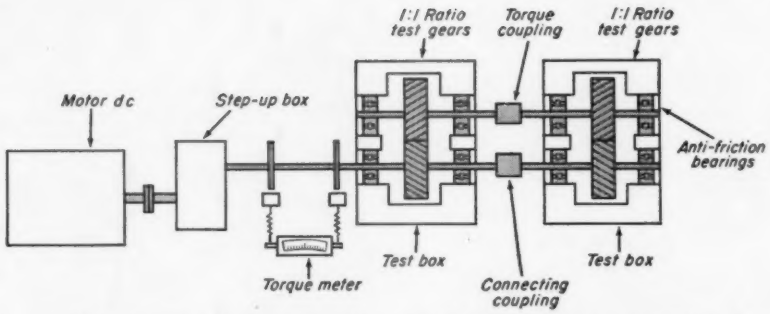

FIG. 1 FOUR-SQUARE TORQUE LOOP for testing spur gear efficiency.

How to check spur gear efficiency

By **EUGENE E. SHIPLEY**, *advance gear engineering, General Electric Co.*

GEAR TRAIN EFFICIENCY is usually so close to 100% that losses are not taken into account during design. However, it can give trouble if ignored, particularly when large amounts of power are being transmitted. A method for measuring losses is shown.

Losses in a gear box are: (1) windage losses, (2) bearing losses, and (3) gear mesh losses. This article is concerned only with the third, gear mesh losses. Since efficiencies of power transmitting elements are often expressed as a coefficient of friction, it is decided to determine the average coefficient of friction for gears in mesh at various speeds.

Test Method

In order to isolate the mesh losses, first measure the total losses and then separate the components. The four-square gear-test principle used, Figure 1, consists of coupling two similar gear boxes in tandem. One gear set can be torqued against the other to simulate loading. The driving motor supplies only the static and dynamic friction losses of the two.

This permits accurate measurement of circulating horsepower and losses. Oil flow and temperature measurement are easily adjustable to assure consistent conditions. Determine losses in one gear box by dividing total losses by two. The validity of doing this has been questioned since one gear box is running in a step-up direction while the other is being run in a step-down direction. To eliminate this, run the tests on a one-to-one gear set in both boxes. This simplifies bearing loss measurements. Since all bearings are running at the same speed and have the same load and are lubricated with the same oil, errors are eliminated.

The bearing test device has a shaft with four of the bearings in one of the gear boxes. This averages individual bearing losses and when the test is repeated with different sets of similar bearings, they repeat very closely.

Torque measuring is electronic and capable of measuring a change of less than 1 in-lb.

General curves for the collected and computed data are shown in Figure 3. Total losses for the complete loop are of the form shown in Figure 3a. This is windage, bearing losses and gear mesh losses. The curve at no load in Figure 3a consists only of windage losses. By subtracting it from the total loss curves, the curves of Figure 3b which consist only of bearing and gear mesh losses are obtained. Data collected from

This article is abstracted from a paper presented at the 1st American Society of Lubrication Engineers Gear Symposium, Morrison Hotel, Chicago, January 26-27, 1959.

Nomenclature

D = pitch dia. of pinion, in.
E = efficiency of gear mesh, %
F = face width of thinner gear, in.
f = coefficient of friction
H = specific sliding velocity of teeth
K = load factor, tooth loading
N = gear ratio where $N = 1$ or larger
n = pinion speed, rpm
P = power loss of gear mesh, %
R = pitch radius of larger gear, in.
R_o = outside radius of larger gear, in.
r = pitch radius of pinion, in.
r_b = base radius of pinion, in.
r_o = outside radius of pinion, in.
s = path of approach, in.
t = path of approach, in.
V = pitch-line velocity, ft/min
W = driving load at pitch radius,;
W_t = tangential component;
W_n = normal component
Z = friction force
Z = friction force; $Z = f W_n$
θ = pressure angle, deg
ω = angular velocity of pinion, rad/sec

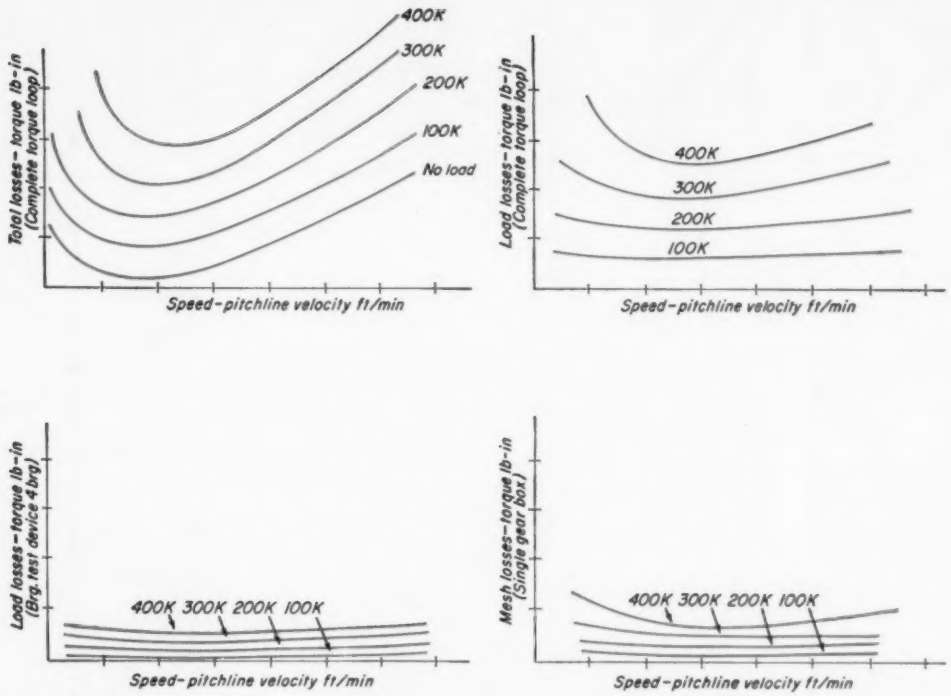

FIG. 3 Generalized curves of test data used in determining in determining gear efficiency.

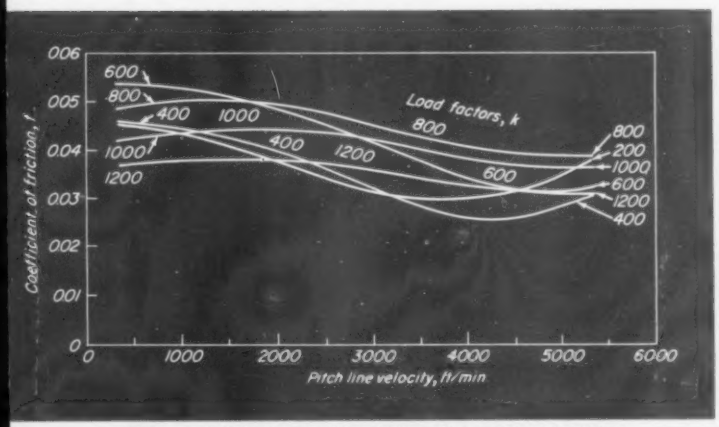

FIG. 2 AVERAGE COEFFICIENT OF FRICTION for gears tested.

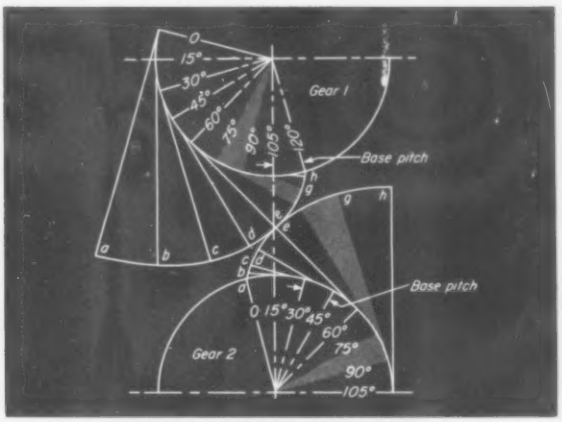

FIG. 4 INVOLUTE PROFILES of angular segments are not equal.

bearing tests, Figure 3c, is then subtracted from values of Figure 3b to leave gear mesh losses, Figure 3d.

Equations Developed

Power losses can be computed by multiplying the measured torque losses by speed. Equations were developed to relate average power loss to average coefficient of friction. In terms of per cent power loss for a simple set of gears, power loss is,

$$P = \frac{50f}{\cos\theta}\left(\frac{H_s^2 + H_t^2}{H_s + H_t}\right) \quad \text{.....(1)}$$

where

$$H_s = \left(\frac{N+1}{N}\right)\left(\sqrt{\left(\frac{r_o}{r}\right)^2 - \cos^2\theta} - \sin\theta\right) \quad \text{..(2)}$$

and

$$H_t = (N+1)\left(\sqrt{\left(\frac{R_o}{R}\right)^2 - \cos^2\theta} - \sin\theta\right) \quad \text{...(3)}$$

In deriving the power loss equations, several basic factors are,

1. gear tooth surfaces move across each other with a combination of rolling and sliding velocity. Therefore, power loss is a function of sliding motion.
2. For two involute gear surfaces to transmit constant angular motion, the base pitches of both gears must be equal. However, the equivalent angular segments of the involute profiles that mesh together are not equal.
3. For a 1:1 ratio set of gears, the sliding velocity is a maximum at the first point of contact, reduces to zero at the pitch diameter, changes

direction and increases again to a maximum at the last point of contact. By approaching the problem from the torque transmitted at any instant, expressions for the instantaneous power loss P_l at the end of the arc of recess are

$$P_l \text{ (recess)} = \omega Zt \left(\frac{N+1}{N}\right) \quad \text{.....(4)}$$

$$P_l \text{ (approach)} = \omega Zs \left(\frac{N+1}{N}\right) \quad \text{.....(5)}$$

the average power loss is

$$P_L = \left(\frac{\omega Z}{s+t}\right) \left(\frac{N+1}{N}\right) \left(\int_0^s s\,ds + \int_0^t t\,dt\right) \quad \text{..(6)}$$

which gives

$$P_L = \frac{\omega Z}{2}\left(\frac{N+1}{N}\right) \left(\frac{s^2+t^2}{s+t}\right) \left(\frac{\text{in-lb}}{\text{time}}\right) \quad \text{.(7)}$$

Average power transmitted is

$$Pt = \omega W_n r_b \quad \text{.....(8)}$$

The percent power loss P is then the ratio of P_L to P_t, multiplied by 100. This ratio, when substituting values for s and t results in the power formula given in equation 1.

$$E = 100 - P \quad \text{.....(9)}$$

Test

The test gears were mounted in each test box and the contact was adjusted for 100% contact on each mesh. The complete apparatus was operated at no-load to check out vibrations and temperature rise. The torque loop was then loaded to 200 K and operated for several hours for run-in purposes. During this period all instrumentation was checked for proper operations and functioning. Increasingly higher K-factors were imposed on the gear sets until the complete torque loop and loading cycles were checked out. Once the system was in proper working order, tests got under way to measure the torque losses of the complete torque loop as a function of K-factor load and speed. Other test conditions are given in table 1.

First the no-load conditions were run and data were taken at various speed intervals. At each measuring point the test stand was allowed to reach equilibrium before any torque measurements were made.

The torque loop was then loaded at 200 K, 400 K, 600 K-etc., until the whole program was completed. At each load level sufficient data was taken so that a curve of torque loss vs. speed could be plotted. As each new load was imposed on the gear sets, an additional break-in period was provided (200,000 load cycles), before any readings were recorded. Once the various load levels were completed cross checks were made at intervals as a measure of the repeatability.

TABLE 1. TEST SPECIFICATIONS

gears	spur	oil	Grade 1005 (MIL-O-6081A-1005)
pressure angle	20 deg		
diametral pitch	5	temperature	120-125°F
ratio	1:1	flow	2.5 gpm
no. of teeth	30	direction of flow	ingoing side of mesh
face width	1 inch	tooth contact	100%
material	9310	surface finish	11 micro inches
heat treat	case carb.		varied zero to 5000/min
hardness	60 Rc	speed	varied zero to pitch line velocity
final machining	ground	load	1200 K-factor

The bearing testing device was run in a similar manner to the torque loop device, except, of course, it was set up in only one test gear box. The test procedure followed pretty much the same pattern as that used when the complete sets of gearing were run. Data were taken that again related bearing loss torque to various speeds in question.

Once complete sets of data were taken for both the bearing testing device and the test gear sets in the torque testing loop they were processed. Final results of these tests are shown in Figure 2. Average coefficient of friction f, varies with K-factor load and the pitch line velocity. For any given K-factor load, f starts out high, dips to a minimum, then starts to climb again. These curves seem to follow hydrodynamic theory in that high friction values occur during boundary lubrication conditions. The friction values reduces to a minimum then climbs with continued increase in pitch line velocity. It was unfortunate that the test equipment limited the pitch line velocity obtainable to approximately 5,000 ft/min since it would be of great value to know what happens to f, as the various curves start to climb.

The minimum point of the curves seems to move further to the right as the K-factor loads are increased. This again may be explained by the hydrodynamic theory in that as the load is increased it takes greater speed, pitch line velocity, in order to build up an oil film. There also seems to be a point where the K-factor load reaches a value at which f, the average coefficient of friction reaches a maximum. As the load is increased beyond this point the average coefficient of friction is definitely lower. Figure 2 shows the 800 K-factor curve is higher than the 1000 K-factor curve which is again higher than the 1200 K-factor curve. There seems to be no ready answer for this. However, there may be some apparent explanation which has been overlooked.

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Internal Combustion Engines

12 page booklet pertaining to the Internal Combustion Engine Institute. Cites objectives and activities of institute, advantages of belonging and various types of engine applications.

Internal Combustion Engine Institute, Chicago, Ill.

Circle No. 152 on reader service card

Way Bearing

Four page bulletin illustrating recirculating anti-friction way bearing. Tychoway bearing is available in varied loads from 2000 lbs to 32000 lbs in standard and precision matched sets, permits unlimited travel.

Circle No. 153 on reader service card

Gearmotors

Catalog titled "Crofts Ritespeed Geared Motors and Reduction Gears" describes items, tells how they are totally enclosed and fan-cooled. Listed are prices and dimensions, especially on gearmotors from ½ hp to 15 hp.

Rockwood Pulley Manufacturing Co., Inc., New York, N. Y.

Circle No. 155 on Reader Service Card

Gear Drives

Four-page bulletin No. 2350, describes new lines of motorized gear-drives. They are powered by frame motors mounted on a shelf attached to the reducer.

The Louis Allis Co., Milwaukee, Wisc.

Circle No. 156 on Reader Service Card

Pulleys

Eight-page bulletin No. 558, describes curve-crown design of welded, all-steel pulleys. Rim gives maximum belt training effect and keeps wear to a minimum.

Stephans-Adamson Mfg. Co., Aurora, Ill.

Circle No. 157 on Reader Service Card

Pillow blocks

Bulletin TA-757. Describes and illustrates triangle pillow block bearings, especially adapted to air-conditioning and heating equipment.

Triangle Manufacturing Co., Oshkosh, Wisc.

Circle No. 158 on Reader Service Card

Differential

Describes the spin-resistant differential, tells how it transfers power automatically to the wheel that has greater traction, pre-loaded cone brakes, and side gear thrust. Warner Automotive Division,

Borg-Warner Corp., Auburn, Indiana.

Circle No. 159 on Reader Service Card

Variable speed motors

Sixteen-page booklet titled "Variable RPM's Control Production Tempo"; well illustrated in color, lists advanced features, shows how infinite speeds are instantly obtained by reciprocal diameters, reveals dial speed control in a well-drawn diagram.

U. S. Electrical Motors, Inc., Los Angeles, Cal.

Circle No. 160 on Reader Service Card

MEN *continued*

Union Chain eastern mgr.

Elmer M. Richardson has been appointed eastern regional manager of the Union Chain & Mfg. Co., Sandusky, Ohio. Mr. Richardson will supervise operations of the Boston, New York, and Philadelphia territories, with headquarters in New York City.

Chf. Eng. New Departure

J. P. Gillilan is now assistant chief engineer of New Departure Division, General Motors Corp. Formerly, he was assistant to general sales manager for New Departure.

Hydraulics Ltd. chairman

I. E. Weston is now chairman of the board and general manager of Weston Hydraulics, Ltd., subsidiary of the Borg-Warner Corp.

Southern representative

Michigan Tool Co., Detroit, Mich., announces that the Shop Supply Co., Birmingham, Ala., has been named sales and engineering representative for the company in four southern states. The sales firm will also represent Michigan's Gear-O-Mation Division. The firm's territory covers the entire state of Alabama, ten counties in Florida, thirty counties of Mississippi, and sixty-one counties in Tennessee.

Gisholt officer passes

George E. Gernon, 87, secretary of the Gisholt Machine Co., passed away recently. He served with the company for 58 years.

Sundstrand Packmaster

Sundstrand Machine Tool Co., Rockford, Ill., announces the acquisition of all design, manufacturing, and sales rights to the line of Packmaster automatic packaging machinery. Sundstrand-Packmaster machines will be built and sold through Sundstrand's American Broach Division, Ann Arbor, Mich.

Buhr management promotions

Buhr Machine Tool Co., Ann Arbor, Mich., announces the following appointments: Edward A. Farwig as manager of proposals, pricing, and orders; and John Hamal to represent the company on its complete line of multiple-operation machine tools in northern Ohio and western Pennsylvania.

New Departure sales

Mark Goedecke is now a sales engineer with New Departure Division, General Motors Corp. Prior to this, he was supervisor of engineering, Northwest Region.

U.S. Rubber appointment

F. Dudley Chittenden has been appointed manager of Marvinol operations, Naugatuck Chemical Div., U.S. Rubber Co.

Hydrodyne Corp.

Donald Z. Erle is now chief engineer, fluid control devices, Hydrodyne Corp.

Goodyear plastics mgr.

H. D. Allick has been appointed manager of the Plastics Dept., Chemical Div., Goodyear Tire & Rubber Co.

Singleton new NEMA pres.

J. L. Singleton, Allis-Chalmers Mfg. Co., has been elected president of the National Electrical Mfrs. Assn.

New R. & D. director

Linwood A. Walters has been appointed director of research and development, National Vulcanized Fibre Co.

Hoover International, Inc.

The Hoover Ball & Bearing Co., Ann Arbor, Mich., announces that the company will form Hoover International, Inc., a wholly-owned subsidiary, and has acquired a substantial interest in Nishi Nippon Seiko (NSK) of Otsu, Japan.

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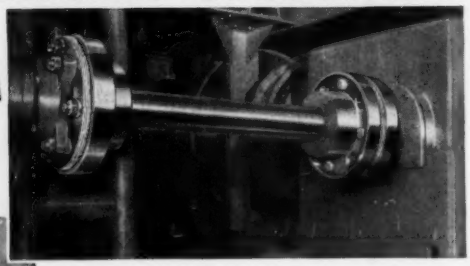

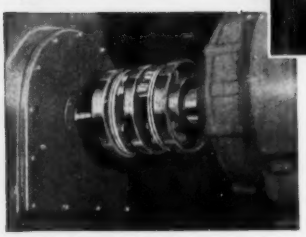

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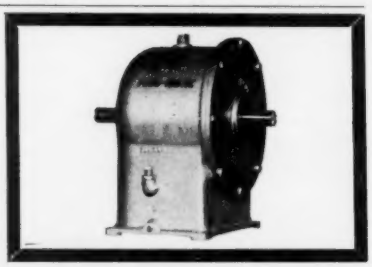

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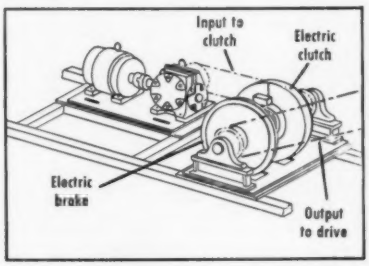
electric motion control facts

for IDEA MEN

Electric Clutch-Brakes Control Automation Drives!

There may be an idea here for you in the way Ford Motor Co. uses electric brakes and clutches to control automation equipment in one of their stamping plants.

Following a plant-wide program aimed at conserving high-pressure air and reducing downtime, Ford engineers installed electric brakes and clutches on extractors, elevators, carryovers, and shuttles used for automatic handling of Mercury body parts. As a result, many control and maintenance advantages were gained along with the primary objectives of the program



A good example is in the welding of front floors, which is done on a "T"-shaped machine with feeder lines coming in from both ends of the "T". The job starts with nine individual drawn parts in the pretacking stations to form the "ladder" assembly, which is solid-welded to the floor pan in a series of fast, automatic operations.

Automated shuttles, elevators, and carryovers are powered by right-angle drives controlled by Warner electric clutch-brakes, actuated by limit switches. The sketch shows Ford's standard mounting for Warner drives used in this plant.

Torque adjustment like tuning a radio

Packaged controls, Fig. 1, permit accurate adjustment of torque build-up so the positioning devices deliver the parts to the exact location for welding or movement to the next operation. For example, the main shuttle drive, Fig. 2, is controlled by three limit switches on top of the rail. Moon-shaped cams on the carriage actuate the switches, and a clutch-brake stops the shuttle. Then, the part is flipped over onto a roller conveyor for transfer to the skids. Controls for the clutch-brake are mounted in the central panel. Rheostats for adjusting the amount of current flowing to the clutch or brake fields permit accurate control of torque. Thus, Ford engineers get exactly the right positioning motions as the parts flow through the line.

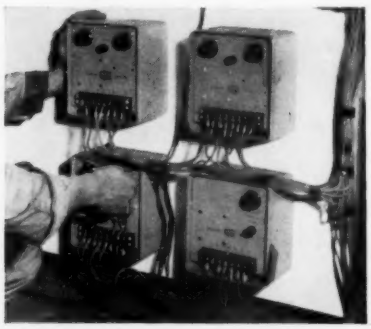


Fig. 1—Rheostats in Warner controls permit tuning torque up or down to get exact speed characteristic desired for each part-handling operation.

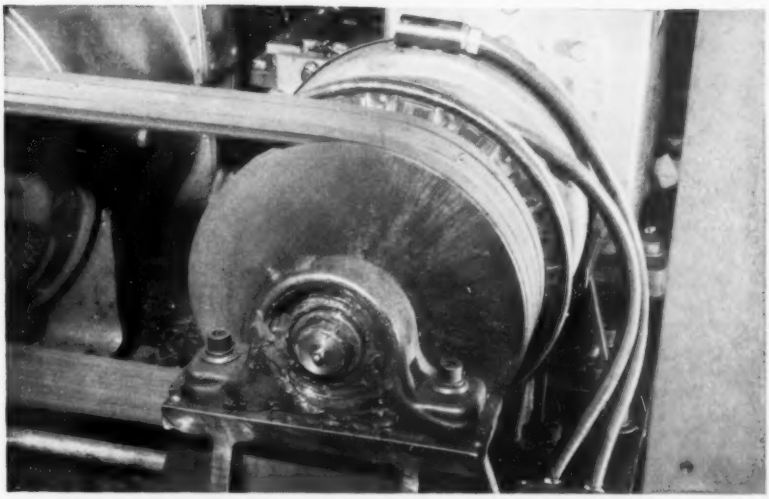


Fig. 2—Main shuttle drive is controlled by Warner No. 1525 electric clutch and two No. 1525 electric brakes. Moon-shaped cams on the carriage actuate three limit switches on top of the rail, releasing the clutch and engaging brakes. The main shuttle takes the floor front assemblies all the way through the press welder.

The Warner brakes and clutches require no special shielding and operate at high duty cycles without heating up. No replacement parts have been required after two years of steady operation in the Ford welding line.

New concept in power transmission

One of the design advantages of the Warner units for automation tooling is the almost complete integration of electrical actuation and electromagnetic operation. Response is instantaneous. They require only 30 watts of d-c to energize the field coil. Fast release when the field is de-energized permits rapid switching from brake to clutch. There are no mechanical linkages, no piping of fluid or air—just quickly strung electrical connections to the fields. Maintenance is minimized. There are no wear adjustments to make. Units are mounted easily on through shafts, taking input torque from sprockets, pulleys, or gears through the pin-mounted armatures. Brake armatures are mounted on drive pins to standard hubs keyed to the jackshaft. The entire drive can be designed and built by your personnel to meet your specific requirements.

Modernize your machines

Your factory-trained Warner representative or distributor can help you start a power drive modernization program that will make your plant more profitable. He has the most complete line of electric clutches, clutch-couplings, clutch-brakes, and brakes to choose from, with torque ratings up to 100 hp.

Want more IDEAS?

Application data sheets show you how to modernize machines, conveyors, and other power-driven equipment. Warner electric brakes and clutches expand the opportunities for using automatic controls in your plant, speed up machinery, and eliminate hard-to-maintain controls. Ask your nearby Warner distributor or write to:

WARNER ELECTRIC BRAKES AND CLUTCHES

Warner Electric Brake & Clutch Co.
Beloit, Wisconsin

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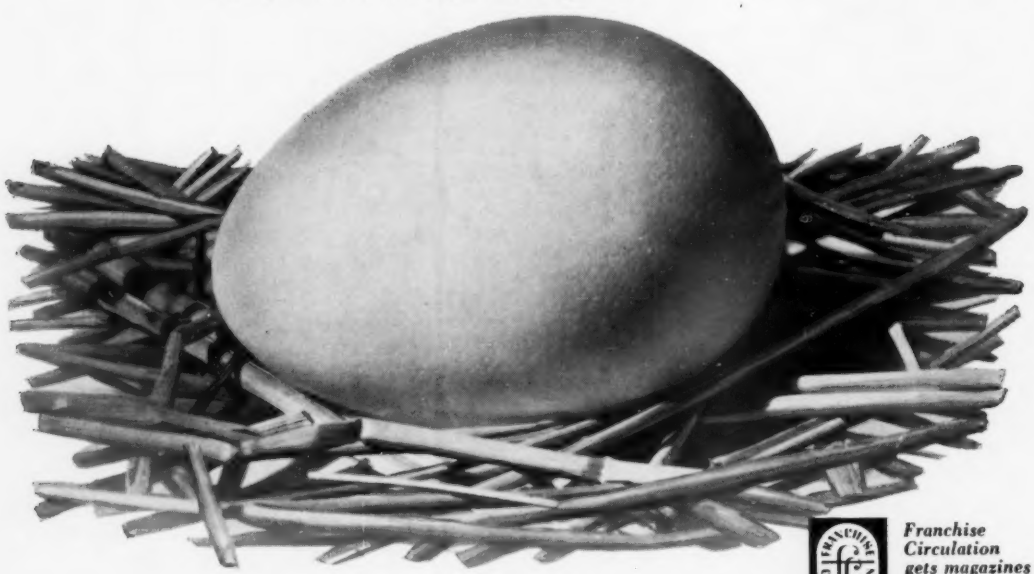

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